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PELLA, MILTON O. * AND OTHERS
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*SCIENTIFIC ATTITUDES, *LITERACY, *CITIZENSHIP RESPONSIBILITY, *SCIENTIFIC CONCEPTS, *SCIENCE EDUCATION, LITERATURE GUIDES, ELEMENTARY SCHOOLS, SECONDARY SCHOOLS, COLLEGES, MADISON, WISCONSIN

THIS PROJECT ESTABLISHED PLANS FOR THE ANALYSIS OF THE RESEARCH ESSENTIAL TO DEFINE AND DEMONSTRATE THE DIMENSION OF SCIENTIFIC LITERACY NEEDED BY CITIZENS IN A DEMOCRATIC SOCIETY DURING AN AGE OF RAPID SCIENTIFIC AND TECHNOLOGICAL CHANGE. THE OBJECTIVE WAS TO DETERMINE THE KINDS AND DEGREES OF COMPETENCE ESSENTIAL TO INFORMED CITIZENSHIP AND FUTURE EMPLOYMENT. PROCEDURES FOLLOWED INCLUDED (1) THE INTERVIEWING OF A LIMITED NUMBER OF SCIENTISTS, INDUSTRIALISTS, SCIENCE EDUCATORS, AND LABOR LEADERS, (2) THE STUDY OF CERTAIN NONTECHNICAL MAGAZINES AND NEWSPAPERS, AND (3) THE PREPARATION OF WORKING PAPERS CONCERNED WITH SCIENTIFIC LITERACY AS DEFINED BY THIS STUDY. THE SCIENTIFICALLY LITERATE INDIVIDUAL PRESENTLY IS CHARACTERIZED AS ONE WITH AN UNDERSTANDING OF THE BASIC CONCEPTS IN SCIENCE, NATURE OF SCIENCE, ETHICS THAT CONTROL THE SCIENTIST IN HIS WORK, INTERRELATIONSHIPS OF SCIENCE AND SOCIETY, INTERRELATIONSHIPS OF SCIENCE AND THE HUMANITIES, AND DIFFERENCES BETWEEN SCIENCE AND TECHNOLOGY. EVIDENCE FROM ANALYSIS OF THE LITERATURE CONCERNED WITH SCIENTIFIC LITERACY REVEALS THAT KNOWLEDGE OF THE INTERRELATIONSHIPS OF SCIENCE AND SOCIETY, ETHICS, AND NATURE OF SCIENCE ARE MORE IMPORTANT THAN CONCEPTUAL KNOWLEDGE, DIFFERENCES BETWEEN SCIENCE AND TECHNOLOGY, AND THE INTERRELATIONSHIPS OF SCIENCE AND THE HUMANITIES. (JL)

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SCIENTIFIC LITERACY
in the Aerospace Age

Bureau Number 5-8222

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Co-investigators:

Dr. Milton O. Pella
Dr. George T. O'Hearn
Dr. Lindley J. Stiles

The University of Wisconsin
Madison, Wisconsin
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Dr. Calvin W. Gale
Assistant Professor of Science Education

Mr. Roger L. Wood
Research Assistant

Mr. Charles D. Boerner
Research Assistant

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A. Bibliography: Scientific Literacy

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Introduction

The teaching of science in elementary schools, secondary schools and colleges is carried on for three basic reasons;

1. To prepare scholars in the several disciplines of science.
2. To provide the background required of individuals entering technological occupations or professions as electronics, engineering, medicine, etc.
3. To provide a background in science as a part of the general education of the individual for effective citizenship.

The concern of this study is with science for effective citizenship which has been referred to as scientific literacy by Bailey (1957), Behnke (1960), Carleton (1963), Clem (1950), Evans (1962), Hurd (1958), Johnson (1962), Kusch (1960), McCurdy (1958), Shamos (1963), Ubel (1961), Waterman (1960), Weaver (1962), Wittlin (1963), and many others.

Problem I.

To determine the referents included in the literature pertaining to scientific literacy.

Problem II.

To determine the opinions of a sample of representative of industry, science news writers, educators and representatives of the military concerning what knowledge in and of science is important to their respective businesses and/or professions and for effective citizenship.

Problem III.

To determine through the analysis of samples of daily and Sunday newspapers and popular magazines:

1. The number of articles that were scientifically and/or technologically oriented.
2. The nature of the themes of the scientifically and/or technologically oriented articles.
3. The distribution of the articles found when a classification of science and/or technology is imposed.
4. The number of articles that involve science and/or technology that have one or more social implications.
5. The nature of the social implications included in articles that involve science and/or technology.
6. The knowledge in and of science prerequisite to the reading of the selected articles.

Problem I.

To determine the referents included in the literature pertaining to scientific literacy.

Procedure.

Step I. - Selection of documents for analysis.

The Reader's Guide to Periodical Literature and The Educational Index from 1946-1964, were systematically searched for titles concerned with:

1. Scientific literacy.
2. Science and/or technology and the citizen.
3. Relationships or interrelationships of science and/or technology and society and social problems.
4. Relationship of science and technology.
5. Science and/or technology and culture.
6. Relationship between scientists and non-scientists.
7. Science and the public domain.
8. Science and general education.
9. The scientific and/or technological revolution.

B. The following Journals from 1950-1964 were systematically searched for relevant titles.

1. American Journal of Physics
2. Physics Today
3. Science
4. Scientific American
5. The Bulletin of the Atomic Scientists
6. The Science Teacher

C. The card catalog of the Memorial Library of the University of Wisconsin was systematically searched for relevant titles.

D. Consultations were held with selected scholars from the Department of Botany, Zoology, Chemistry, Physics, History of Science, Sociology, History, and Education at the University of Wisconsin.

E. Consultations were held with two newspaper Science Editors.

F. The bibliographic references cited in each of the documents analyzed were searched for relevant titles.

Step II. - Analysis of the documents.

Each document was carefully studied in terms of the following questions:

A. What does the author mean by scientific literacy, science for the citizen, science for general education, etc.?

B. Does the author indicate referents to scientific literacy? If so, what are the referents?

C. Does the author discuss scientific and/or technological needs of citizens? If so, what are these indicated needs?

The data in terms of referents were tabulated according to content and source.

Results.

With the completion of the analysis of 66 documents, it was found that the referents were being repeated and no new referents were appearing. The analysis of an additional 34 documents failed to reveal new referents.

PRECEDING PAGE MISSING

The six referents emerged as a consequence of placing together those statements from the 100 documents with associated meanings. The illustrations that follow are typical statements or meanings found in the documents analyzed:

Science and society: Statements typical of the concern for science and society are:

1. Science and technology are the chief internal sources of change in our society.

2. Science and technology are causing a fundamental revolution to occur in the structure of our society.

3. Citizens must be aware of what science is and what it is not, what its strengths and values are, and where its limitations lie,

4. Social consequences of scientific knowledge are great and cannot be predicted in advance.

5. With advances in science and technology in such areas as automation come the social and economic problems of employment restructuring.

6. Development of new scientific knowledge is necessary to a sound and vigorous economy.

7. Productivity in our society is becoming increasingly dependent on science.

8. The American public ultimately governs the support of science and the use of its achievements.

9. Communication between the scientific community and the public is essential if the voting public and the national leaders are to make wise decisions.

10. Most important social and political problems are related to science and technology.

11. Our present world is powered by science.

12. Understanding science and technology is necessary for wise participation in a democracy.

13. Science and technology interact directly with our society.

14. Science in our society is dependent upon the value placed upon critical rationality throughout society.

15. Behind technological and social innovations lies the primary source, science itself.

16. Science does not have its social consequences at a distance, in some kind of a social vacuum, but rather interacts with the rest of society to produce these consequences.

17. Science is the most powerful means devised by the mind of man for arriving at truth in respect to the world of matter and energy and indeed also the realm of mind and behavior. Science is the great force in human life making for change in ways of living through increased power to alter and control the environment. Science is the greatest liberating liberalizing force in human thought. It is obvious that in the modern world the strength of a nation, whether in war or in peace resides in its science. The future solutions of the most critical problems of society - the problems of uncontrolled population increase and insufficient food and water, sources of energy and supplies of raw materials, and the imperative task of mobilization skills - lie in the applications of science.

18. The purpose of scientific education is to (1) help laymen adjust to the technological devices which surround their daily lives, (2) create an informed public capable of taking an intelligent part in those decisions of our society which involve science and scientific activity.

This referent thus has several dimensions as: science is the root of social change, society controls science through control of resources, the intelligent control and direction of science in a democracy depends upon an informed public, science interacts with society to produce social change with or without technological change, science has done much to liberate man from bondage due to superstition and associated beliefs, science and technology have created social problems never before faced by a society, science and technology are key elements for future social development, science and technology have limitations, and the lay public must come to understand the scientist and his ways.

The building of a better interrelationship between science and society leads to five elements that need recognition and study: (1) perceptions of man's relationship to nature, (2) the meaning of science as presently interpreted by formalized education, (3) the interrelationship between science and scientists and social policy makers, (4) the effect of a political culture on the activities of scientists, and (5) the continued concern for current knowledge by the adult population.

REFERENCES: SCIENCE AND SOCIETY

American Association for the Advancement of Science (1960)
Ashby, Sir Eric (1960)
Auger, Dr. Pierre (1949)
Bailey, H. S. (1957)
Barber, Bernard (1952)
Barber, Bernard and Walter Hirsch (1962)
Baum, Werner A. (1962)
Behnke, John (1960)
Bolton, Laetitia (1958)
Caldwell, Lynton (1964)
Clem, Orlie M. (1950)
Cohen, I. (1952)
Conant, J. (1946)
Carleton, Robert (ed.) (1963)
Davis, J. B. (1964)
De Jouvenel, Bertrand (1963)
DuBridge, Lee (1964)
Dupree, A. Hunter (1961)
Evans, Hubert (1962)
Freilich, Florence G. (1965)
Glass, Bentley (1959)
Hildebrand, Joel H. (1955)
Hoagland, H. (1959)
Holton, Gerald (1963)
Hurd, Paul DeH. (1958)
Killian, Jr., J. R. (1959)
Kirk, Russell (1963)
Kusch, Polykarp (1960)
LeCorbeiller, Wolfenden, et al. (1963)
Lonsdale, Kathleen (1958)
Mathewson, James H. (1962)
Mathewson, J. H. (1963)
McCurdy, Richard C. (1958)
Mead, Margaret (1959)
Moore, W. I. and Leon N. Henderson (1957)
Muller, H. J. (1959)
Nagel, Ernest (1959)
Newman, James R. (ed.) (1955)
Palmer, Richard (1947)
Pauling, Linus (1951)
Pierce, J. R. (1954)
Polyani, M. (1957)
Potter, Van Rensselear (1964)
Prior, Moody E. (1962)
Rabi, I. I. (1956)
Rapoport, Anatol (1950)
Remmers, H. H. and D. H. Radler (1958)
Rostrand, Jean (1960)
Rotblat, Joseph (1962)
Russell, Bertrand (1960)
Ryder, Edward J. (1960)
Schrodinger, Erwin (1952)
Seaborg, G. T. (1962)
Seitz, Frederick (1958)
Snow, C. P. (1964)
Stratton, J. A. (1956)
Tatara, Walter T. (1964)
Turner, J. (1960)
Waterman, Alan T. (1960)
Waterman, A. T. (1963)
Weaver, Warren (1960)
Weaver, W. (1962)
Weaver, Warren (1957)
Wiesner, Jerome B. (1965)
Withey, Stephen B. (1959)
Wolfle, Dael (1957)
Wright, Palmer (1960)

Ethics of Science

Typical references to the ethics of science are:

1. Science is the most powerful means devised by man for arriving at the truth with respect to the world of matter and energy.

2. The aim of pure science is to increase man's knowledge of the physical and biological world without respect to any present or future good or evil.

3. Pupils must be helped to develop a scientific attitude.

4. Scientific practice produces objective truth and rules for discovering it.

5. Science teaching must ultimately bring about a wider appreciation of the ethical implications of science for the common good.

6. People need an appreciation of the meaning and methods of science.

7. Scientific knowledge requires some encompassing understanding of the whole, some appreciation of causes and connections and of conceptual models and their relationship to observable reality.

8. The layman must learn to judge and interpret the statements and values of scientists.

9. One reason for including the study of science in the scheme of general education is to develop knowledge of the scientific enterprise.

10. The scientist has a duty to report his findings to the general public in a manner the layman understands.

11. Secrecy in science cannot be tolerated, this we must all come to understand.

12. The value of science lies not in the subject matter alone but chiefly in the spirit and living tradition in which the disciplines are pursued.

13. Scientists can greatly affect public opinion and provide leadership for laymen in forming a proper attitude toward science.

14. Teaching of science should emphasize (1) the assumption of order, (2) experimentation and observation, (3) induction of general laws, (4) development of theory, and (5) documentation and dissemination of knowledge.

15. One of the main functions of the scientist should be to instill in the public those mental qualities and attitudes which have made him successful in science, namely, critical analysis of old concepts, constant search for new and superior theories, insistence that all these be based upon evidence rather than generalized idealism and that they be accepted on the bases of prediction and analytic success and not on the strength of their tradition or the power of their special interests.

Certain of the concerns indicated for this referent were expressed as attitudes or the scientific attitude. The scientific attitude is accepted to be the willingness to be controlled by a group of objective rules in the persuance of knowledge. Some authors indicated that this same attitude should regulate life outside of science. It is also noted that some authors specifically delineated the ethics of concern to them in considering scientific literacy.

REFERENCES: ETHICS OF SCIENCE

Arnow, L. Earle (1960)
Auger, Dr. Pierre (1949)
Barber, Bernard (1952)
Barber, Bernard (1959)
Baum, Werner A. (1962)
Behnke, John (1960)
Bolton, Laetitia (1958)
Bronowski, Jacob (1951)
Caldwell, Lynton (1964)
Clem, Orlie M. (1950)
Cohen, I. (1952)
Conant, James B. (1947)
Conant, J. (1946)
Carleton, Robert (ed.) (1963)
De Jouvenel, Bertrand (1963)
Dupree, A. Hunter (1961)
DuShane, G. (1961)
Gibson, R. E. (1953)
Glass, Bentley (1959)
Heitler, W. (1964)
Hildebrand, Joel H. (1955)
Hoagland, H. (1964)
Hoagland, H. (1959)
Holton, Gerald (1960)
Hull, J. D. (1959)
Hurd, Paul DeH (1958)
Johnson, Philip G. (1962)
Killian, Jr., J. R. (1959)
Kusch, Polykarp (1960)
Lachman, Sheldon, J. (1956)
Margenau, Henry (1964)
Mathewson, James H. (1962)
Mathewson, J. H. (1963)
McCurdy, Richard (1958)
Mead, Margaret (1959)
Muller, H. J. (1959)
Nagel, Ernest (1959)
Nash, Leonard (1963)
Palmer, Richard (1947)
Pauling, Linus (1951)
Pierce, J. R.(1954)
Polyani, M. (1957)
Potter, Van Rensselear (1964)
Prior, Moody E. (1962)
Rapoport, Anatol (1950)
Rotblat, Joseph (1962)
Ryder, Edward J. (1960)
Shamos, M. H. (1961)
Shamos, Morris (1963)
Smith, R. B. (1960)
Stewart, B. (1961)
Szent-Gijorgyi, A. (1957)
Waterman, A. T. (1963)
Weaver, Warren (1960)
Weaver, W. (1962)
Weaver, Warren (1957)
Wittlin, Alma S. (1963)
Wolfle, Dael (1957)

Nature of Science

The following statements are indicative of those found in the literature concerning this referent.

1. The citizen must have an improved understanding of how it (science) operates.

2. The main goal of science education is to assure that everyone understand something of the intellectual meaning of what scientists are about.

3. Sensibly educated people can gain a good working idea of how science goes about its business.

4. The study of science should serve to equip students with an understanding of the scientific method as an approach to problem solving.

5. Science is concerned with discovering truth, and with the separation of the true from the false.

6. People should see that science seeks truth by successive approximation existing under the authority of an idea and the quest of theory that will hold up under controlled testing and the replication of experiments.

7. We need a more scientific understanding of science itself.

8. In general education the stress must be toward an understanding by nonscientists and scientists of what science is all about.

9. Your education in science should have given you an appreciation of the work of great scientists and the growth of tested thought.

10. The true nature of modern science is one of reduced empiricism through increased application to theory. (One of the needed understandings of modern man).

11. A wide spread understanding of science is necessary in this country because only through understanding can science be assimilated into our cultural pattern.

12. One purpose of science education is to help the pupil and layman acquire an understanding of the distinctive methods of science.

13. There are reasons why it is imperative that the individual citizens of our democracy have an improved understanding of what science is and how it operates.

14. Science for future citizens should be made intelligible to explain the basic hypothesis and philosophies of science and to give him an acquaintanceship with science.

15. Universitites should assume greater responsibility for interpreting science to the common man.

This referent is concerned with some phases of the process aspect of science. There is considerable emphasis on the understanding of the nature of science, however, the kinds of understanding desired extended from "science is a body of knowledge" to "science is an idea developing activity." The preferences in the documents were for science as a knowledge developing activity, there is no one method of science, and science moves ahead as a series of approximations. There was no consensus as to which of the ideas in the structure of science was most fundamental.

REFERENCES: NATURE OF SCIENCE

Bailey, H. S. (1957)
Barber, Bernard (1952)
Barber, Bernard and Walter Hirsch (1962)
Bronowski, Jacob (1951)
Bronowski, Jacob (1955)
Clem, Orlie M. (1950)
Conant, James B. (1947)
Carleton, Robert (ed.) (1963)
D'Abro (1950)
Dupree, A. Hunter (1961)
Feuer, L. S. (1964)
Freilich, Florence G. (1965)
Gibson, R. E. (1953)
Hildebrand, E. M. (1954)
Hoagland, H. (1964)
Holton, Gerald (1960)
Hull, J. D. (1959)
Hurd, Paul DeH. (1958)
Johnson, Philip G. (1962)
Karplus, R. (1962)
Killian, J. R. Jr., (1959)
Kusch, Polykarp (1960)
Lachman, Sheldon, J. (1956)
Mathewson, James H. (1962)
Mathewson, J. H. (1963)
Moore, W. I. and Leon N. Henderson (1957)
Muller, H. J. (1959)
Nash, Leonard (1963)
Newman, James R. (ed.) (1955)
Novak, Alfred (1964)
Palmer, Richard (1947)
Pauling, Linus (1951)
Poincare, Henri (1952)
Prior, Moody E. (1962)
Roche, M. (1963)
Rostrand, Jean (1960)
Rotblat, Joseph (1962)
Schrodinger, Erwin (1952)
Schwab, Joseph J. (1962)
Seaborg, G. T. (1962)
Seitz, Frederick (1958)
Shamos, M. H. (1961)
Stewart, B. (1961)
Waterman, Alan T. (1960)
Weaver, Warren (1960)
Weaver, W. (1962)
Weaver, Warren (1957)
Wittlin, Alma S. (1963)
Wolfle, Dael (1957)
Woolf, Harry (1964)
Wright, Palmer (1960)

Conceptual Knowledge

Typical statements concerning this referent made in one or more of 26 per cent of the documents are:

1. A knowledge of conceptual science provides the necessary language for communication between the lay public and the scientific community.

2. Key concepts or conceptual schemes are the only answers to the laymans understanding of mushrooming scientific and technological knowledge.

3. Historic and cultural roots of science concepts should be a part of the publics understanding of science.

4. Concepts of science have an impact on all aspects of the school curriculum and should be dealt with in all these areas.

5. Conceptual knowledge of science has brought man a freedom from the slavery of the supernatural.

6. The study of scientific facts and concepts relative to certain controversial topics may produce desirable changes in attitudes with regard to these topics.

The importance of concepts in science instruction varies with some authors emphasizing the need to "keep up" with science, others stress the part played by concept development in science in our culture, and still others express concern for the function of concepts in changing attitudes.

REFERENCES: CONCEPTUAL KNOWLEDGE

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Bailey, H. S. (1957)
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Baum, Werner A. (1962)
Bolton, Laetitia (1958)
Bronowski, Jacob (1951)
Clem, Orlie M. (1950)
Conant, James B. (1947)
Evans, Hubert (1962)
Hoagland, H. (1964)
Holton, Gerald (1960)
Holton, Gerald (1963)
Hull, J. D. (1959)
Johnson, Philip G. (1962)
Kusch, Polykarp (1960)
Mathewson, James H. (1962)
Nash, Leonard (1963)
Newman, James R. (ed.) (1955)
Rostrand, Jean (1960)
Shamos, M. H. (1961)
Shamos, Morris (1963)
Smith, R. B. (1960)
Stewart, B. (1961)
Stratton, J. A. (1956)
Ubell, Earl (1961)
Wright, Palmer (1960)

Science and Technology

Indicated concern for the ability to discriminate between science and technology is revealed in sample statements of meaning.

1. Public understanding of the difference between the short and long run purposes of science and technology are essential to advancing our science and society.

2. Scientific education is to help laymen adjust to the technological devices which surround their daily lives.

3. The educated layman must understand that science is not technology, it is not gadgetry, it is not some mysterious cult, it is not a great mechanical monster. Science is an adventure of the human spirit.

4. The technological aspects could be used as a link between the scientist and the nonscientist.

5. It is important for the citizen to understand clearly the distinction between science and technology.

It is noted that knowledge of the difference between science and technology has apparently taken on importance. The views of technology varied from complete dependence upon science for its existence to the belief that technology has a structure and history of its own. A more common expression was to the effect that science and technology differ basically in ethics and motivation. It was pointed out also that pure science often produces technologically useful knowledge and that applied science often produces conceptual schemes.

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Barber, Bernard (1952)
Baum, Werner A. (1962)
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Clem, Orlie M. (1950)
Dupree, A. Hunter (1961)
Evans, Hubert (1962)
Feuer, L. S. (1964)
Gibson, R. E. (1953)
Lachman, Sheldon, J. (1956)
McCurdy, Richard (1958)
McCurdy, Richard C. (1958)
Prior, Moody E. (1962)
Shamos, M. H. (1961)
Turner, J. (1960)
Waterman, Alan T. (1960)
Waterman, A. T. (1963)
Weaver, Warren (1960)
Wiesner, Jerome B. (1965)
Wolfle, Dael (1957)
Wright, Palmer (1960)

Science and Humanities

The concern of some of the expressions for the cultural aspect of science is indicated by the following statements.

1. The study of science in our schools is carried on without regard for the humanitites and the study of the humanities is carried on without regard to science; yet each is complimentary to the other.

2. The rapidity with which man changes his life and his environment (via science) requires a deep understanding of both science and the humanities and their interrelatedness.

3. Society requires wisdom and consensus for policy decisions which in turn necessitate communication between scientist and humanist.

4. Science is responsible for much cultural change which in turn is a subject of the humanities.

5. The dichotomy between scientific and humanistic scholarship becomes very synthetic if the decision making processes in science are carefully examined.

6. The divorce of the sciences from the humanities is based upon misconceptions.

7. Science is really a humanistic study.

8. Scientific literacy means that an educated man should know science in a humanistic way.

This referent, science and the humanities, was concerned with learning science as a part of the American cultural heritage and with the study of the interrelatedness of science and the humanities. Occasionally an author would use the term humanities to refer to social implications rather than cultural implications. The concern for science as one of the humanities was most prevalent.

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Caldwell, Lynton (1964)
Conant, James B. (1947)
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Glass, Bentley (1959)
Hafstad, Lawrence (1957)
Hurd, Paul DeH. (1958)
Kirk, Russell (1963)
Lonsdale, Kathleen (1958)
Margenau, Henry (1964)
McCurdy, Richard C. (1958)
Mead, Margaret (1959)
Muller, H. J. (1959)
Rabi, I. I. (1956)
Rapoport, Anatol (1950)
Roche, M. (1963)
Rotblat, Joseph (1962)
Schrodinger, Erwin (1952)
Shamos, Morris (1963)
Smith, R. B. (1960)
Waterman, Alan T. (1960)

Summary

The scientifically literate individual presently is characterized as one with an understanding of the (1) basic concepts in science, (2) nature of science, (3) ethics that control the scientist in his work, (4) interrelationships of science and society, (5) interrelationships of science and the humanities and (6) differences between science and technology.

Evidence from analysis of the literature concerned with scientific literacy reveals that knowledge of the (1) interrelationships of science and society, (2) ethics of science, and (3) nature of science are more important than (4) conceptual knowledge, (5) differences between science and technology, and (6) the interrelationships of science and the humanities.

Problem II.

To determine the opinions of a sample of representatives of industry, science newswriters, educators, and representatives of the military concerning what knowledge in and of science is important to their respective businesses and/or professions and for effective citizenship.

Procedure

Personal private interviews were held with representatives of industry, science newswriters, educators, and representatives of the military from the State of Wisconsin.

A. **Selection of the person's for interview**

The individuals selected satisfied one or more of the following criteria.

1. Responsible for the employment practices of his institution.
2. Responsible for 'on the job performance' of employees within his institution.
3. Establish educational programs for institution personnel.
4. Prepares science materials for popular or professional consumption.
5. Was involved with education at some level as elementary, secondary, college, adult, or vocational.

B. **Interview Technique Employed**

1. An open ended semistructured technique was employed so that the interviewee could develop his own logical discourse in discussing scientific literacy.

2. Each interview was recorded on tape and analyzed at a later date.

3. The following questions were inserted into the interview at the appropriate time. Each question was structured apropos to the professional position of the interviewee.

a. What do you understand the term scientific literacy to mean?

b. What are the characteristics of a scientifically literate person?

c. Is literacy in science, i.e. knowledge in and of science, possible for an entire population?

d. Is the scientific literacy, i.e., knowledge in and of science, important for a population?

e. Is it possible to plan educational programs so that the individual may continue to be scientifically literate throughout life? If so, how?

Results.[1]

Interviews were conducted with:

I. Nine representatives of industry including
  a) two personnel directors from a major manufacturing plant that supported a research and development section,
  b) one personnel director from a food processing industry,
  c) two personnel directors from grey iron foundries,

---

[1] The views expressed herein are in no way to be taken as official statements of the particular groups represented. Rather these views reflect only the personal opinions of the 15 individuals interviewed.

d) one vice president of a small manufacturing plant,

e) one personnel director of a utility service company, and

f) two industrial scientists.

II. Three educators including

a) one city superintendent of schools,

b) one school science consultant, and

c) one curriculum coordinator of a vocational school.

III. Two science newswriters.

IV. One military officer.

Question A. What do you understand the term "scientific literacy" to mean?

This direct question proved to have little meaning to the first five people interviewed. Because of the lack of basis for communication this question was discontinued.

Question B. What are the characteristics of a scientifically literate person?

The term scientific literacy had little or no meaning for the representatives of industry first interviewed. Therefore, the question was restated as follows:

What knowledge in and of science is important to an individual for his job and for a citizenship?

I. The following opinions were common to seven of the nine industrial representatives.

a. Job performance of a man on the production line is not dependent upon his knowledge of the concepts or methods of science or the impact of science on society.

b. Knowledge of the interaction of science and society is irrelevant to job performance and to effective citizenship since the citizen must turn to the expert for decisions much as he turns to the physician when he is ill.

c. Knowledge of technological developments which exist within a community is desirable.

Individual typical comments were:

> "In our company we are interested in the science background of an employee if and only if it is prerequisite to the job."

> "We look for men with manual and technical training. These could be picked up in high school in a physics or shop course, in the military, and other places."

An opinion common to the two industrial scientists was knowledge of certain basic (but unspecified) concepts of science is important for all individuals, particularly those in technical or managerial positions.

One industrial scientist whose firm employs high school graduates as laboratory technicians strongly urged the understanding of the processes of science. His statement indicates his concern.

> "When we hire an individual we prefer him to have biology and chemistry or physics or both. We then start by assuming he knows nothing. There are certain methods of science which are important and we teach them these necessary analytical procedures. We want him to report (his lab observations) honestly. We can train him to do this quite easily. I doubt that he learns this in the high school but we find it very easy to train him to do this.... I don't think that the factual content of courses is nearly so important as the way of looking at the problem...with an individual skepticism and a way of determining the relevant facts. I don't know how to teach this but I know it can be taught...we do it here in this lab...it can be taught in the high school lab too."

II. The three educators agreed on the importance of what they termed the basic knowledge of science concepts and methods commonly found in high school science courses as a starting place for future development.

The representative of the vocational school pointed out that (a) the growing social and moral problems created by more widespread use of science and technology were becoming more and more a concern for the general citizen as well as for the technical worker, and (b) the knowledge of these problems and ways to cope with them are necessary for citizenship and for effective employment.

III. The two science newswriters agreed that for effective citizenship and employment the individual should:

a. Understand the methods of science

b. Possess a knowledge of the concepts or theories of science

c. Recognize the social importance of science and technology.

One of the newswriters strongly emphasized the importance of knowledge of the specific facts of science as known today for employment and citizenship.

The second newswriter indicated that...

> individuals don't have to understand the technical detail of new scientific results, e.g., DNA, but they do need to be able to put these new results in proper perspective...not how it is that the scientists are investigating this phenomenon (DNA) but that now with the knowledge of DNA scientists are more able to ask and answer questions of how biological organisms reproduce themselves. We might say that the scientifically literate individual needs to know how science is important to modern life and how the individual sciences fit into the scheme of life. It is more important for the individual to know how science effects his life than knowing the individual facts of science.

V. The representative of the military cited specific skills such as laboratory techniques, knowledge of basic electronics, and mechanics as being needed by all branches of the armed services.

Question C. Is literacy in science, i.e. knowledge in and of science, possible for the entire population?

I. Seven of the representatives of industry gave no relevant answers.

II, III, IV. The three educators, two industrial scientists, and two newswriters agreed that a minimal level of scientific literacy, characterized by ability to read news accounts of scientific and technological developments is possible for most of the literate individuals. More advanced levels of scientific literacy are both necessary and possible for decision makers such as Congressmen.

V. The representative of the military gave no relevant answers.

Question D. Is scientific literacy, i.e., knowledge in and of science, important for a population?

I. The nine representatives of industry offered differing opinions on the importance of knowledge in and of science for the various segments of the population.

1. Six of the representatives of industry agreed that:
   a) Knowledge of science is neither relevant nor important to the worker on the production line in the performance of his job.
   b) Knowledge in and of science may be important for the administrative employee and general citizen but this importance cannot be easily judged.

c) Decisions in such special matters as science and technology are best left to the experts much as the physician decides on the treatment for specific illness.

2. The representative of a foundry stated that all his employees have a stake in the products being produced and in the utilization of these products, therefore, the social aspects of science and technology, specifically the irresponsible use of the new products of science and technology and the misuse of natural resources concern the man in the mill, the executive in the front office, and the general citizen.

3. The two industrial scientists stated that a minimal knowledge in and of science is important for employment, advancement, and effective citizenship.

II. The three educators agreed that knowledge in and of science is important because our society is becoming more heavily dependent on science to technology. This increases the need for understanding of science and technology if the democratic process is to prosper.

III. The two science writers agreed that minimal levels of knowledge in and of science are essential for employment and citizenship. One writer discussed the need for increased understanding of all aspects of science and technology by decision makers in industry, education, and government.

IV. The representative of the military stated:

a) Military operations are becoming increasingly technical, therefore knowledge in and of science is essential for military personnel.

b) No opinion on the importance of scientific knowledge for the entire population.

Question E. Is it possible to plan educational programs so that an individual may continue to be scientifically literate throughout life? If so, how?

I. The nine representatives of industry provided three opinions.

a) For hourly employees: specific knowledge of science is not relevant to their job and so the question is not relevant for this group.

b) For salaried employees: most industries already have advanced study programs which provide encouragement, time, and/or tuition money for advanced study. Such study is usually but not necessarily related to the individual's current job.

The representative of the food processing corporation pointed out that the salaried employees of his firm are invited to attend early morning in-service educational programs within the plant. So far two such programs have been offered; a course in economics for the consumer and a course in the dynamics of practical politics in our society. Both of these courses were offered because the employees requested or were interested in such work. He concluded that if such a program were available in scientific literacy his firm would be interested in offering it to their employees. The industrial scientists noted that television is probably the most effective adult education medium available. It should be used more extensively for programs on science and technology.

II. The three educators agreed that through the effective use of the mass media the individual citizen can continue to be scientifically literate. The representative of the vocational school emphasized the importance of continuing formal adult education in which all aspects of science and technology and their interactions with society are emphasized.

III. The two science newswriters indicated that they belived educational programs could be developed. They also noted that once the individual citizen has left institutions of formal learning the mass media are his principle contacts with new developments. Therefore, what is needed is a concerted effort to produce science news stories, T.V. programs, etc., the objectives of which are not only informing the public but more specifically keeping the public scientifically literate.

IV. The representative of the military indicated that he believed that continuing literacy was possible and pointed out that for military personnel:

a) Knowledge in and of science is essential and is continuing to be one of the reasons for the extensive military educational programs.

b) Rapidly changing science and technology is decreasing the effective useful life of specific courses or skills.

c) This creates a need for more and continuing education in the fundamentals of mathematics and the sciences as a base upon which new specific skills could readily be built.

d) For the citizen: All necessary information in and of science can be carried in the newspapers and magazines.

Summary

The data on this problem are too sparse and inadequate for the drawing of reliable conclusions. Further data were not gathered because of the apparent lack of understanding of the problems by the groups interviewed and the consequent lack of reliability of the generalizations that could be forumulated from such data.

The majority of the individuals interviewed, with the exception of the educators, industrial scientists, newswriters, and the military representative reported that they had not thought about this problem before. The concern they have with production employees is to get them to produce while the concern for management level employees is quite different.

a. What do you understand the term "scientific literacy" to mean?

Lack of previous concern for this topic on the part of the interviewees was given as a reason for lack of understanding of its meaning.

b. What knowledge in and of science is important to an individual for his job and for citizenship?

There were differences of opinion between the industrialists (nonscientist) and others. The type of industrialist concerned with manufacturing expressed the opinion that knowledge in and of science became a concern of his only when such knowledge was directly applicable on the job. The consensus of opinions of industrial scientists, newswriters, educators, and the representative of the military indicated beliefs that some basic (1) knowledge in science,

(2) understanding of the methods of science, and (3) understanding of the interrelationships of science and technology and society were important for employment and citizenship.

The nonscientist industrialists did express some concern that the layman should know something of the relationship of technological developments and their use by society.

Within each group there were differences in the nature of the details of the opinions expressed.

c. Is literacy in science, i.e., knowledge in and of science, possible for the entire population?

The seven nonscientist industrialists and the military representative gave no relevant answers.

The industrial scientsts, educators, and newswriters expressed the opinion that a minimal level of literacy in science was possible. Again there were variations in attempts to define or describe minimal level. However, it was most commonly characterized as the ability to read news accounts of scientific and technological developments.

d. Is scientific literacy, i.e., knowlege in and of science, important for a population?

The industrialists (nonscientists) were generally consistent in their opinions; they repeated that it was not important for the layman, for his job, or for citizenship since this segment of the population would always have to go to experts for help. The industrial scientist, one manufacturing industrialist, educators and the newswriters, were of the opinion that the scientific literacy of the general population was important.

e. Is it possible to plan educational programs so that an individual may continue to be scientifically literate throughout life? Is so, how?

The industrialists (nonscientist) indicated a negative response because, in their opinion, this question was not relevant. The opinion here was consistant with the opinion given in question b. It was reported that for salaried employees most industries had educational programs.

In spite of the lack of concern of this group for scientific literacy, the opinions expressed indicate that the necessary information in and of science could be carried in newspapers and magazines and on T.V. It was further indicated that T.V. is probably the most effective adult education medium available and it should include more educational programs involving science and technology.

The science newswriters, educators, and the representative of the military were of the opinion that scientific literacy for life was possible and could be accomplished through the schools during early life and through mass media after leaving school. This group included within its discussion such topics as knowledge of the content of sciences, the nature of science, technological developments, the relationship of science and society, the way society uses its resources, the kinds of technological devices placed on the market, and the place of science in society.

Problem III.

To determine through the analysis of samples of daily and Sunday newspapers and popular magazines:

1. The number of articles that were scientifically and/or technologically oriented.

2. The nature of the themes of the scientifically and/or technologically oriented articles.

3. The distribution of the articles found when a classification of science and/or technology was imposed.

4. The number of articles that involve science and/or technology that have one or more social implications.

5. The nature of the social implications included in articles that involve science and/or technology.

6. The knowledge in and of science prerequisite to the reading of the selected articles.

Related Research.

One of the first significant newspaper studies with respect to science content was reported by Finley and Caldwell (1923) who studied the biological material appearing in eleven prominent newspapers for the month of June, 1921 and in six newspapers for November, 1921. They found that health was the most prominent topic in newspaper biology.

Curtis (1924) investigated the scientific knowledge required for an intelligent reading of the public press. He studied 2,783 newspaper articles and found that articles on biological science were about as numerous as those on physical science, and that about

67 per cent of the newspaper articles on biological science required a foundation of technical knowledge, as contrasted with about 25 per cent for physical science.

Hopkins (1925) analyzed all the issues of four Denver newspapers for one month and eight magazines for six months for articles of a scientific nature. He found biological articles to occur most commonly in the newspapers and non-scientific magazines and, omitting the two technical magazines read, that physics and chemistry articles combined accounted for less than one-fourth the space devoted to biology.

To determine what scientific information the public pays for in standard magazines and the relative amounts of these materials devoted to the various sciences, Searle and Ruch (1926) analyzed the science content of all the issues of eight magazines for a 10 year period and three magazines for a five year period. They found that 62.2 per cent of the science content of these magazines could be classified as relating to biology, 26.3 per cent to physics, 5.1 per cent to chemistry, and the remaining 6.4 per cent to general science.

Merrill (1929) analyzed a sample of magazines and bulletins covering approximately a 13 year period for information concerned with groups of plants and the particular activities or relations of the various plant groups. His findings showed that writers of periodical literature devoted more than seven times more space to consideration of food-producing groups of plants than did textbook writers. In an analysis of 12 high school biology texts he noted that three times more space was devoted to lower froms of plant life than in the periodicals, but that the periodicals devoted more than seven times more attention to the economic phase of plant life than did the textbook writers.

Hill (1930) analyzed the biological content of 861 articles in 591 issues of nine non-specialized magazines. He concluded that the greatest emphasis in these magazines was placed upon animal biology which accounted for 52.8 per cent of the content followed by human biology which accounted for 28.62 per cent.

Kutz (1932) analyzed the public health and hygiene content of 240 issues of the New York Times, The Morning World, and the Evening Graphic. Of the 4,364 items identified, 1,536 were news items, 122 were editorials and the remaining 2,706 were advertisements.

Novak (1942) analyzed the New York Times for the years 1930, 1933, 1936, and 1939. He found that 20.1 per cent of the newspaper science content was devoted to health and medicine and that 50.5 per cent of the science content was biological (including health and medicine) and 49.5 per cent was physical science.

In an attempt to determine what information newspapers were giving their readers about atomic energy Hines (1947) analyzed every item relating to atomic energy published in specific editions of five newspapers during the month of August. He found that in general the five newspapers were devoting almost a column a day to news, editorials, or other material concerning atomic energy. His study also revealed that, generally, the greatest percentage of the news on atomic energy was devoted to political policy followed by research in atomic energy and background or historical news.

A study of the content of selected U. S. dailies by the Department of Agricultural Journalism of the University of Wisconsin showed that the percentage of front page science varied from 3.3 per cent for the Louisville Courier to 0.0 per cent for the Madison Capital Times and that the percentage of non-advertising space devoted to science varied from 2.0 per cent for the Louisville Courier to 0.3 per cent for the Capital Times.

Reeves (1950) found through the analysis of seven newspapers that 43 per cent of all science articles pertained to the H-bomb and 57 per cent to all other sciences and that 60 per cent of the front page science was related to H-bomb stories, 14 per cent to medicine, and the remaining 26 per cent to various other areas of science.

Rowe (1951) found that 0.9 per cent of all the non-advertising space of a sample of 100 newspapers analyzed was devoted to science. Of all the science articles read, 35.2 per cent were in the field of medicine, 20.8 per cent in atomics, 14.3 per cent engineering, and the remaining 29.7 per cent in various other areas of science.

Koelsche and Morgan (1964) analyzed the science content of 22 daily newspapers and nine magazines for a period of six months. They found that 62 per cent of all science articles in the newspapers appeared in the months of November and December and that 87.3 per cent of the science articles in the newspapers were almost equally divided between the fields of biology and physics. In the magazine study they found that 58.7 per cent of all the articles dealt with some phase of the biological sciences, 28.4 per cent with physics, and the remaining 12.9 per cent to other areas. They also tabulated the scientific principles and vocabulary they felt were necessary to interpret and understand the scientific information appearing in these science articles.

Procedure.

I. Selection of capitol city newspapers
  A. Capitol city newspapers were selected as follows:
    1) The 50 states were classified into nine geographical areas as specified by N. W. Ayers and Sons, Newspapers and Periodicals, - 1964.
      a) New England
      b) Middle Atlantic
      c) East North Central
      d) West North Central
      e) South Atlantic
      f) East South Central
      g) West South Central
      h) Mountain
      i) Pacific
    2) A minimum of two states was selected from each area as follows:
      a) States were listed alphabetically and numbered serially 1-50.
      b) States were selected by use of random number table until a minimum of two states had been

selected for each geographic area. When 22 states had been selected a minimum of two states had been chosen from each of the nine areas.

3) The capitol city daily newspaper was identified in each of these 22 states. The newspaper with the greatest circulation was chosen in cases of cities with more than one daily newspaper.

B. A six month subscription for each of the 22 selected newspapers was begun on August 1, 1964 and terminated January 31, 1965. A listing of the selected newspapers is given in the appendix.

C. The selection of daily issues to be read for each of the 22 capitol newspapers was as follows:

1) The 22 newspapers were listed alphabetically by state and numbered serially.

2) The August 1, 1964 issue of the first daily newspaper on the list was selected for analysis; the August 2, 1964 issue of the second paper on the list was selected for analysis; and so on until the August 26, 1964 issue of the 22nd newspaper on the list was selected for analysis. Sunday papers were omitted in this selection procedure, hence the difference between the newspaper number and date of the issue selected for analysis.

3) The selection process was recycled beginning with the August 27, 1964 issue of newspaper number 1. The cycling process was repeated until January 30, 1965.

4) For newspaper titles not publishing a Saturday or holiday edition the issue from the preceding day was selected.

D. Selection of the Sunday editions of the newspapers: From the total of 27 Sunday editions received for each of the 19 newspapers that published a Sunday edition three Sunday issues were selected for analysis. Selection was made by use of a table of random numbers.

II. Selection of Magazines

A. The ten magazines classified as "General Editorial" (consumer magazines appealing to the general public) by N. W. Ayers and Sons, Newspapers and Periodicals, 1964 that reported a circulation of three million or more were listed for possible inclusion in the study. From this list were excluded:

1. The two weekly magazines appearing as supplements to Sunday newspapers;
2. The Farm Journal, since it was determined to be a Journal for a specific trade or profession;
3. "Look Magazine" since it was considered to serve the same interest as "Life Magazine" which was included.

To this list of six "General Editorial" magazines were added the two women's magazines of greatest circulation. The names and circulation figures of these eight magazines are given in the appendix.

One monthly issue of each of the eight selected magazines was read beginning with August, 1964 and terminating with the January, 1965; thus, six issues of each selected magazine were read. For those magazines with two or more issues per month, the first issue for each month was selected.

Problem III - 1. Newspaper Study

To determine the number of articles that were scientifically and/or technologically oriented.

Method of Analysis

The selected newspapers were carefully read and all articles with a scientific or technological orientation were clipped and filed for future analysis. Articles were included in this study if they met one or more of the following criteria:

1) Made reference to some scientific or technological development.
2) Involved a social, political, or economic issue concerning science and/or technology.

Excluded from this study were articles concerning:

1) Crop reports of a statistical nature.
2) Commercial development or trade items as hearing aids, automobiles, televisions, etc.
3) Advertisements.

4) Obituaries.

5) Daily weather forecasts.

6) Reports of consequences of weather.

7) Names of diseases or operations suffered by individuals when the article merely reported same.

8) Medical and scientific meetings unless the science content of such meetings was discussed.

9) Comics.

10) All articles less than 1/2 column inch long.

Results

There were 414 articles with a scientific and/or technological orientation found in the sample of 157 daily and 57 Sunday newspapers. The daily papers included 276 articles and the Sunday papers 138 such articles.

Problem III - 2. Newspaper Study

To determine the nature of the themes of the scientifically and/or technologically oriented articles selected from newspapers.

Method of Analysis

After the scientific and/or technological articles were selected from the newspapers the name and theme of the article were tabulated. The theme was considered to be the one statement which:

a) Best summarized the content of the article as determined by the reader.

b) Was supported by at least 50 per cent of the article.

c) Was consistent with the summary statement contained in the article.

To establish the reliability of the method of identifying the themes a second reader independently determined the themes of a 40 per cent sample of the selected articles. The accepted method produced agreement of greater than 95 per cent between the themes identified by the two readers.

The themes were grouped or classified according to their content and the resulting classification scheme examined.

Results

The grouping of the articles according to individual theme resulted in the establishment of five major themes which best summarized the nature of the individual themes. These five major themes are:

1) Space
2) Automation - Cybernetics
3) Science
4) Nuclear Energy
5) Medicine

The kinds of article themes classified within each major theme are:

Space - Articles dealing with the development of space vehicles and weapons, methods of detecting these space vehicles, and the training of the personnel who will accompany the space probes.

Automation - Cybernetics - The study and/or use of computers, automated machinery, and/or automated systems.

Science - Pure or applied science in each of the following areas: agriculture, anthropology, astronomy, human biology, general biology, chemistry, conservation, engineering, geology, meteorology, oceanography, and physics.

Nuclear Energy - The use or effects of radioactive materials and the production of energy from nuclear sources.

Medicine - Human biology associated with the diagnosis and treatment of disease and illness, the health and nutrition of the public, and the isolated facts of natural or artificially induced body functions.

The number of articles classified within each of the major themes is found in Table III.

TABLE III

Number of Scientifically and/or Technologically Oriented Newspaper Articles Classified According To Major Theme

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Totals
Total (Dailies)	60	4	87	10	115	276
Sunday Editions	33	3	51	10	41	138
Total - Dailies plus Sunday	93	7	138	20	156	414

It is noted that 156 or 37.7 per cent of the 414 articles in both Sunday and daily papers were concerned with Medicine, 138 or 33.3 per cent were concerned with Science, 93 or 22.5 per cent were concerned with Space, 20 or 4.5 per cent were concerned with Nuclear Energy, and 7 or 1.7 per cent were concerned with Automation-Cybernetics.

When daily issues only were considered it was found that 115 or 41.6 per cent of the article themes were classified as Medicine, 87 or 31.5 per cent were classified as Science, 60 or 21.7 per cent as Space, with only 10 or 2.4 per cent classified as Nuclear Energy and Automation-Cybernetics respectively.

When Sunday issues only were considered it was noted that 51 or 36.9 per cent of the articles themes were classified as Science, 41 or 29.7 per cent as Medicine, 33 or 23.9 per cent as Space, and 10 or 72 per cent and 3 or 2.2 per cent classified as Nuclear Energy and Automation-Cybernetics respectively.

Problem III - 3. Newspaper Study

To determine the distribution of the articles when a classification of science and/or technology is imposed.

Method of Analysis

Criteria:

The classification of an article as scientifically or technologically oriented was based upon the ends to which the information or content of the article was directed. An article was classified as technology if it described or interpreted how a product or process was or would be used or if it showed or implied a practical application of scientific or technological concepts or principles. An article was included in the classification science if it described or explained a scientific development in terms of basic concepts, principles, or theories of science without regard to practical application. An article was classified as Both if it contained both science concepts, principles, and/or theories and also described or implied a possible practical application of one or more of the concepts, principles, and/or theories of concern.

Results

TABLE IV

Number of Newspaper Articles Oriented Toward Science, Technology or Both, Classified According to Major Theme

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Technology	85	7	54	19	147	312
Science	-	-	69	-	-	69
Both Science and Technology	8	-	15	1	9	33
Total	93	7	138	20	156	414

Examination of Table IV reveals that 312 or 75 per cent of the 414 articles included in this study may be classified as oriented toward technology. When the articles were subclassified according to major theme as well as science and/or technology it was found that:

1) Eighty five or 91 per cent of the 93 articles concerned with Space were classified technology and the remaining 9 per cent as both science and technology.

2) Seven or 100 per cent of the articles concerned with Automation-Cybernetics were technologically oriented.

3) Fifty four or 39 per cent of the 138 articles concerned with Science were technologically oriented, 69 or 50 per cent were science oriented, and 15 or 11 per cent were classified as both

science and technology.

4) Nineteen or 95 per cent of the 20 articles classified within the theme Nuclear Energy were technologically oriented.

5) One hundred forty seven or 94 per cent of the articles with a major theme of Medicine were technologically oriented and nine articles or six per cent of the articles were science oriented.

TABLE V

Number of Newspaper Articles Oriented Toward Science,
Technology, or Both Classified According
To Major Theme in the Daily and Sunday Issues

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Daily:						
Technology	53	4	33	9	106	205
Science	-	-	44	-	-	44
Both Science and Technology	7	-	10	1	9	27
Sunday:						
Technology	32	3	21	10	41	107
Science	-	-	25	-	-	25
Both Science and Technology	1	-	5	-	-	6

When daily issues were considered it was noted (Table V) that 205 or 74 per cent of the 276 articles were technologically oriented, 44 or 16 per cent were science oriented, and 27 or 10 per cent were oriented toward both science and technology.

The data, when Sunday issues were considered, were similar proportionately to the daily issues with 107 or 77 per cent of the 138 articles technologically oriented, 25 or 18 per cent science oriented, and six or 4.2 per cent both science and technology oriented.

Problem III - 4. Newspaper Study

To determine the number of articles that involve science and/or technology that have one or more social implications.

Method of Analysis

A. Criteria

An article was considered to have a social implication if that article made reference to an immediate or projected effect upon or relationship to society in some form as technological application, judgments of citizens or their elected representatives, financial grants by public or private agencies, social mores, and/or employment.

B. Procedure

A count was made of the number of articles within each major theme class that included some social implication.

Results

TABLE VI

Number of Newspaper Articles Including Some Social Implication Classified According To Major Theme and Science and/or Technology

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Daily	15	2	22	7	21	67
Sunday	6	3	10	5	9	33
Total	21	5	32	12	30	100
Science	0	0	5	0	0	5
Technology	17	5	24	11	29	86
Both Science and Technology	4	0	3	1	1	9

It was found that only 100 or 24.1 per cent of the 414 scientifically and/or technologically oriented articles included some social implication and that the proportion of the totals in daily and Sunday papers was similar. Study of Tables III and VI reveals that the proportion of the articles with some social implication, when classified according to major theme, is characterized by variability from 100 per cent for Automation-Cybernetics articles in Sunday papers to 18.2 per cent for Space articles in Sunday papers when the total number of articles in a group is 10 or fewer. However, when the number of articles in a group is 22 or more the range is only from 18 per cent for Medical articles in daily papers to 25 per cent for Space articles also in daily papers.

It is also noted that only seven per cent of the 69 articles classified as science included some social implication whereas 28 per cent of the articles classified as technology and 27 per cent of the articles classified as both included such an implication.

It is further noted from Table VI that of the 67 such articles occurring in the daily papers, 15 or 22.2 per cent were classified Space; two or 3.0 per cent Automation-Cybernetics; 22 or 32.8 per cent Science; seven or 10.5 per cent Nuclear Energy; and 21 or 31.4 per cent Medicine. Similarly of the 33 articles occurring in the Sunday papers, six or 18.2 per cent were classified Space; three or 9.1 per cent Automation-Cybernetics, 10 or 30.3 per cent Science; five or 15.2 per cent Nuclear Energy and nine or 27.3 per cent Medicine.

Problem III - 5. Newspaper Study

To determine the nature of the social implications included in articles which involve science and/or technology.

Method of Analysis

A catalogued list was prepared consisting of statements describing the nature of the social implications in each of the 100 articles. Some articles could be described by one statement while others required more than one. The items on the list were then examined and grouped on the basis of similarities and differences in terms of social concern. The individual items, classified according to a specific social concern, were then again grouped according to the major theme of the article that served as its source. The individual items within each social concern class grouped according to major theme were then summarized.

Results

1. There were 124 statements of concern prepared that identified

the nature of social implications either implied or directly stated in the 100 articles.

2. The 124 statements indicated: a) interrelationships between society and science and/or technology (social), b) political decisions or issues that involved science and/or technology (political), or c) economic relationships that involved science and/or technology (economic). The 124 statements were thus classified as social, political or economic.

A statement of concern was considered to be social when the discussion involved the direct effect or involvement of science and/or technology upon individuals or groups in a society. Some items were health, leisure, safety and employment.

A statement of concern was classified as political if it involved a voting judgment, right, or responsibility of the citizen or his duly elected or appointed representative concerning a scientific or technological problem.

A statement of concern was classified as economic when it related to a financial cost or gain and also involved a scientific or technological problem.

TABLE VII

Number of Statements Indicating Social Implications Classified According to Concern, Major Theme of the Newspaper Article, and Science, Technology or Both

	Space			Automation-Cybernetics			Science			Nuclear Energy			Medicine			Total		
	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic
Science	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	5
Technology	4	12	5	4	-	3	13	9	10	5	5	4	25	4	5	51	30	27
Both Science and Technology	1	-	3	-	-	-	-	-	3	1	1	1	-	-	1	2	1	8
Total	5	12	8	4	-	3	13	9	18	6	6	5	25	4	6	53	31	40

3. Table VII reveals that 53 or 42.7 per cent of the 124 items of social concern were classified as social, 40 or 32.3 per cent were classified as economic, and 31 or 25 per cent were classified as political.

4. It is obvious from Table VII that the articles classified as technology included more social implications than did those classified as science; 108 or 87.1 per cent of the social implications were found in articles concerned with technology, of which 51 or 47.2 per cent were classified as a social concern and the balance about equally divided between political and economic concerns.

5. When the social implications are considered in terms of the major theme classifications it is noted that 40 or 32.2 per cent occurred in the Science articles, 35 or 28.2 per cent in

Medical articles, 24 or 19.4 per cent in Space articles, 17 or 13.7 per cent in Nuclear Energy articles and only seven or 5.6 per cent in articles concerned with Automation-Cybernetics.

6. A comparison of the proportional distribution of the number of items of social, political, and economic concern within and among the major theme classifications tabulated in Table VII shows that Space articles included more political concerns than any of the others, Medicine articles were more concerned with social problems, Science articles were most concerned with economic problems and the articles classified as Nuclear Energy have about equal concern for the three types.

7. The social items of concern in the articles included those of public opinion, development of public values, effects of automation on employment and increase in leisure time, population explosion, conservation, physical and mental health, nation defense programs, and the effects of increased energy sources. The items of social concern and their frequency of appearance are found in Table VIII.

TABLE VIII

Topics of Social Concern in Newspaper Articles
Classified According to Major Themes

Topic	Frequency
SPACE-SOCIAL	
1. Supersonic tests were conducted over cities by the Air Force to determine the public's reaction to and acceptance of sonic booms.	3
2. The public must make a decision concerning the merits of supporting an expensive space program or supporting research in other areas such as medicine.	1

TABLE VIII (continued)

Topic	Frequency
3. Cutbacks in aerospace contracts will affect a large segment of the population in California since many of the people are employed by industries oriented towards the space program.	1
AUTOMATION AND CYBERNETICS-SOCIAL	
1. The computer revolution will lead to a shorter work week and thus give the worker more leisure time. This leisure time could cause serious social problems.	1
2. The computer will not decrease total employment. However, it will eliminate many present jobs and create new jobs of a different type.	2
3. The use of the computer to study social problems could help eliminate or reduce social tensions and create more wealth and leisure.	1
SCIENCE-SOCIAL	
1. Urban sprawl has created serious problems relating to sewage, fresh water, "breathing space", and preservation of national beauty and wildlife.	4
2. More leisure time of the American citizens will require an expanded outdoor recreational program involving the need for more land.	1
3. Scientific and/or technological research has created new chemical and mechanical products for insect and weed control and an expanded industrial system creating more unusable wastes which are creating serious pollution problems.	7
4. Research on bubonic plague led to the discovery of the rat as its main carrier. Thus, this disease has almost entirely disappeared through extensive rat control programs.	1
NUCLEAR ENERGY-SOCIAL	
1. The use of nuclear weapons upon members of society involves definite moral judgments concerning the consequences of using these weapons.	1

TABLE VIII (continued)

Topic	Frequency
2. The nuclear fallout in the U. S. was very high in 1963 as a result of nuclear testing. This fallout, if allowed to accumulate, could seriously pollute the water and air and cause serious health problems.	1
3. Programs designed for survival "of the bomb" have led to the development of an extensive fallout shelter and civil defense program. The support of these survival programs has been decreasing due to the inquestionable merits in terms of saving lives during a nuclear attack.	1
4. Dr. Teller is hopeful for the development of a "clean" bomb which would have peaceful uses.	1
5. The major problem is to educate the public to the advantages and need for the nuclear energy program.	1
6. The nuclear waste problem is a moral problem. Man is producing a substance which has the potential to destroy his environment.	1
MEDICINE-SOCIAL	
1. The results of research by the American Cancer Society and the tobacco industry have created a controversy involving the relationship between cigarette smoking and lung cancer. This controversy is of deep public concern.	1
2. Medical research has exposed the problem of malnutrition that exists in economically deprived areas of the United States.	1
3. Medical research has exposed the problem of causes of diseases and disorders of the human body that will require development of new treatment procedures.	7
4. Medical research is developing a variety of new drugs and surgical and diagnostic techniques for curbing disease. Misuse of these drugs may cause serious consequences to the user.	14

TABLE VIII (continued)

Topic	Frequency
5. People fail to support medical research because they fail to see the merits and need for research--they fail to see the millions of people aided by this research.	1
6. New drugs and devices for controlling birth as a possible solution to our problem of overpopulation are causing serious discussions among various social groups.	1

8. The concerns of the political topics are basically those involving the Federal Government and the cognizance of the need for the will of the people to be positive if certain programs in science and technology are to be supported, the relationship of certain programs and the international stature of the U. S. and other countries, and the part played by federal agencies in health, research and development programs and projects. The nature of the political topics within the context of the several themes is noted in Table IX.

TABLE IX

Topics of Political Concern in Newspaper Articles Classified According to Major Themes

Topic	Frequency
SPACE-POLITICAL	
1. The government has been reluctant to financially support the supersonic transport system until it is certain of public support.	2
2. A decision by the Federal Government concerning the support of the Mars space program is needed in the immediate future to insure keeping the program on schedule.	1

TABLE IX (continued)

Topic	Frequency
3. Government support of space programs seems to depend upon the military aspects of these programs and not the scientific knowledge these programs may yield.	2
4. Reduction in the defense budget has caused the cancellation of certain missile programs.	2
5. The space administration has decided to combine certain phases of the military and civilian space programs to conserve funds.	1
6. Russia's use of her space achievements has been for national power and prestige.	3
7. A statement issued by the President and his staff reveals that the United States shall become the leading spacefaring nation and that space shall be used as an avenue towards peace.	1
SCIENCE-POLITICAL	
1. The Federal Government must support and take an active interest in the various conservation and land acquisition programs.	2
2. The Federal Food and Drug Administration and the Federal Government must guard against pollution and support the needed antipollution measures.	6
3. Major desalination programs could curb future water problems in parts of the United States and could help alleviate political tensions in the Middle East.	1
NUCLEAR ENERGY-POLITICAL	
1. The decision to drop the atomic bomb on Japan involved a period of soul searching among members of the military, physicists, engineers, and the President and his staff. The decision was based upon the saving of countless American lives that otherwise would have been lost during an invasion of Japan.	1
2. Goldwater opposes the limited nuclear test ban treaty. He maintains that the effects of nuclear weapons upon communication systems must be tested.	1

TABLE IX (continued)

Topic	Frequency
3. Laws, regulations, and controls involving nuclear research must be international.	1
4. The Atomic Energy Commission stresses the need for the peaceful uses of atomic energy to replace fossil fuels in the generation of electricity.	1
5. Should the Federal Government or private enterprise control the future nuclear reactors that will be used to generate electricity?	1
6. The Federal Government is supporting the building of new and more efficient nuclear reactors.	1
MEDICINE-POLITICAL	
1. A comprehensive program is necessary to provide protection to the public against the misuse of drugs and the misuse of diagnostic and therapeutic devices.	2
2. Federal support of medical research is needed to help solve the social problems associated with disease.	2

9. The greatest variety of topics found were those of an economic nature. It is noted from Table X that most of the concern is with the amounts of money being spent by the Federal Government on science and technology with only occasioned concern for the usefulness of the products. There seems to be a recognition that dollars get attention.

TABLE X

Topics of Economic Concern in Newspaper Articles Classified According to Major Themes

Topic	Frequency
SPACE-ECONOMIC	
1. The federal Aviation Agency paid out $7,000	1

TABLE X (continued)

Topic	Frequency
in damage suits filed by citizens of Oklahoma City for damage due to sonic booms.	
2. The supersonic space program would cost the Federal Government $1.2 billion.	2
3. Various issues involve the expenditure of monies for space projects such as: $140 million for the Nimbus Space Project, $49 million for the OGO Satellite Program, $180 million for previous unsuccessful Ranger probes, and $75 billion to land a man on Mars.	5
AUTOMATION-CYBERNETICS-ECONOMIC	
1. The use of a computer in controlling various industrial processes has resulted in greater production, decreased costs, and greater efficiency thus yielding a higher financial gain for industry.	2
2. The Public Health Service has issued a grant of $1.67 million to study the feasibility of using electronic computers to aid in the diagnosis of heart problems.	1
SCIENCE-ECONOMIC	
1. The Federal Government has appropriated large amounts of money for antipollution measures such as $29 million for the development of harmless substitutes for insecticides and herbicides and $200 million for saline water research.	2
2. Project 70 is a $70 million land reclamation program financed by the State of Pennsylvania to preserve some of the "breathing space" still left in the state.	1
3. The Federal Government must appropriate more money for the purchase of national park areas and recreational lands	1
4. Water diversion projects have caused economic hardships in certain tourist areas.	1

TABLE X (continued)

Topic	Frequency
5. The removal of pesticides and insecticides from public use before adequate substitutes are developed will cause an increase in food production costs, thus increasing the cost of food to the consumer.	3
6. The Federal Government appropriated $15 billion for scientific research for 1965.	1
7. The costs of federally financed basic science research projects vary in amounts such as $4.8 million for a biotron at the University of Wisconsin, $7 million for the Antarctic research program, and $46,000 to study the homing behavior of the penquin.	5
8. The results of scientific research may lead to greater financial gain for private enterprise. Examples include the increased financial return to crop growers as a result of agricultural research; financial gains to commercial fishermen as a result of stream, lake, and ocean research; and the creation of new products and industries resulting in increased employment opportunities.	4
NUCLEAR ENERGY-ECONOMIC	
1. The expenditure of money for civil defense has been steadily decreasing due to lack of federal support.	1
2. The AEC spends about $3 billion annually for research and development of peaceful uses of atomic energy.	1
3. The cost of generating electricity by use of a nuclear reactor is presently higher than using fossil fuels but this differential is decreasing.	1
4. The disposing of nuclear reactor waste is an expensive project if adequate safety is to be assured.	1
5. The AEC has appropriated $100 million for a nuclear power plant in California. Its main function will be to supply power to pump water for various irrigation projects.	1

TABLE X (continued)

Topic	Frequency
MEDICINE-ECONOMIC	
1. Federal support of medical research involves grants of $10 million for leukemia research, $15 million for the Salk Institute, and $7 million for study of arthritis and rheumatism.	3
2. The annual loss in wages due to various diseases, especially arthritis and rheumatism, is over $1.5 billion.	1
3. The Federal Government has appropriated $10 million to support a program designed to educate the public concerning the problems and dangers of cigarette smoking.	1
4. Nutritional quackery is seen as one of our biggest frauds involving the abuse of scientific knowledge and is a multi-billion dollar business.	1

Problem III - 6. Newspaper Study

To determine the knowledge in and of science prerequisite to the reading of the selected articles.

Method of Analysis

1. Prerequisite knowledge was defined as all scientific or technical words, phrases, and ideas and all words of general usage which were used in a scientific or technical manner in the selected articles. Excluded were those terms, phrases, or ideas which were not directly related to the theme of the article and those that were related to the theme but were explained or defined within the article. The remaining terms, phrases, or ideas represented the minimum prerequisite knowledge in and of science to reading the article.

2. All articles with prerequisite knowledge were identified

and classified according to the major theme of the article.

3. Each item of prerequisite knowledge was identified within each major theme and an explanation or definition was formulated that was specific to the context of the article.

4. A classification system based upon the traditional disciplinary lines of physics, chemistry, etc. was imposed upon the items of prerequisite knowledge. A tabulation was then made of the articles within each theme with prerequisite knowledge.

5. The reliability of the technique of identification of the items of prerequisite knowledge was tested by having a sample of approximately 20 per cent of the articles read by two other individuals competent in science. The technique was revised until a reliability of at least 90 per cent was achieved.

Results

TABLE XI

Number of Articles in Daily and Sunday Newspapers
with Knowledge in and/of Science Prerequisites

Newspaper	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Daily	51	3	59	7	94	214
Sunday	26	3	36	9	37	111
Total	77	6	95	16	131	325

1. Utilizing the data in Tables III and XI it is revealed that 325 or 78 per cent of the 414 articles (daily and Sunday) have some science knowledge prerequisites. It is also noted that 214 or 76 per cent of the daily articles and 111 or 80 per cent of the

Sunday articles have some science knowledge prerequisites.

2. An examination of these data, according to major themes, indicated that 51 or 85 per cent of the 60 Space articles from the daily papers and 26 or 79 per cent of the 33 Space articles from the Sunday papers had science knowledge prerequisites. Of the total of 93 articles classified Space 77 or 83 per cent had science knowledge prerequisites.

3. In the articles within the theme Automation-Cybernetics three out of four of the daily articles and the three Sunday articles had science knowledge prerequisites.

4. Of the 138 articles with the theme Science 95 or 69 per cent had science knowledge prerequisites. These included 59 or 65 per cent of the daily and 36 or 71 per cent of the Sunday articles.

5. The theme Nuclear Energy included 20 articles 16 of which had science knowledge prerequisites. The 16 included seven of the ten daily and nine out of the ten Sunday articles.

6. The 156 articles with the theme Medicine included 131 or 84 per cent that had science knowledge prerequisites. Of the 94 daily articles 82 per cent had science knowledge prerequisites which compares closely with the 37 or 90 per cent of the Sunday articles requiring such knowledge.

TABLE XII

Items in and of Science Prerequisite to the Reading of the Selected Newspaper Articles and their Frequency of Appearance Classified According to the Major Theme of the Article and Academic Discipline

Prerequisite Knowledge[1] ([1]Definition or explanation limited to that specifically required in context of the article or articles.)	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
I. ANTHROPOLOGY					
1. Aborigines are the first known inhabitants of a region.			1		
2. Aryan is an individual of Indo-European origin.			1		
3. Cro-Magnon was a prehistoric race of man that lived on the European continent.			1		
4. Neanderthal man is the name given to man at the stage of the development attained during the stone age.			1		
Sub Total			4		
II. ASTRONOMY					
1. Anti-satellite missiles are used to seek out and destroy satellites.	2				
2. Stars are classified according to their brightness. The brightest stars in the night sky are called first magnitude stars. The next brightest stars are called second magnitude stars. The first magnitude stars are about two and one-half times brighter than the second magnitude stars. This is referred to as an astronomical brightness scale.					

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
3. The earth's atmosphere tends to cause distortion in photographs of objects beyond the earth's atmosphere. Placing a telescope outside of the earth's atmosphere would alleviate this problem.	1				
4. Atmospheric radiation or radiation from space consists of charged particles such as mesons and high speed electrons and electromagnetic radiations of various frequencies (such as x-rays and cosmic rays.) emitted from certain objects in space.	4				
5. The Aurora Borealis is a series of luminous bands of light seen in the night sky of the Northern Hemisphere. It originates in the layer of the atmosphere called the ionosphere and is believed to be caused by charged particles emitted from the sun striking the ionosphere producing a glow or light.	2		1		
6. A celestial body is an aggregation of matter in the universe that constitutes a unit (as a planet, moon, sun) for astronomical study.	1				
7. A comet is a heavenly body consisting of a head and a long nebulous tail. It becomes illuminated as it orbits the sun.	1				
8. Constellations are groups of stars that appear to form patterns in the sky.	1		1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. Cosmic rays consist of a stream of atomic nuclei of a heterogeneous, extremely penetrating character that enter the earth's atmosphere from outer space and cause intensive ionization of the ionosphere.	3		1		
10. An eclipse of one satellite takes place when a second satellite passes in front of the first blocking out the light or view of that satellite.	1				
11. An elliptical orbit is a path in the shape of a symmetrical oval.	1				
12. An equatorial orbit is a path around the earth concentric to and above the earth's equator.	1				
13. Full moon is that phase of the moon when the illuminated half is fully visible from earth.			1		
14. Galaxies are groups of millions of stars.			3		
15. The ionosphere is an electrically charged layer in the earth's atmosphere which is capable of acting as a mirror for radio or radar waves, that is, it is able to reflect radio or radar waves back to earth.	5		1		
16. During times of intense sun spot activity intense radiation is released from the sun's surface. This radiation enters the earth's atmosphere and causes severe distortions in the layer of the atmosphere called the ionosphere. Since the ionosphere is essential to long range radio communications, disturbances in this layer cause major disturbances in radio communications.	3		1		

TABLE XII (continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
17. A light year is a unit for measuring great distances in the universe. One light year is the distance light travels in one year.			2		
18. Lunar pertains to the moon.	3				
19. A lunar eclipse occurs when the earth moves between the sun and the moon and the earth's shadow falls on the moon's surface.			1		
20. The magnitude of a star is its relative brightness in relation to other stars. The brightest stars are called first magnitude stars, the next brightest are second magnitude stars, etc.			1		
21. Meteoroid detection satellites are primarily used to detect and record the number of meteors and bits of space dust that they encounter in their specific orbits around the earth.	1				
22. Meteors are pieces of solid material and/or cosmic dust found beyond the earth's atmosphere in outer space.	1				
23. Micrometeorites are extremely small fragments of meteors that enter the earth's atmosphere and fall to the earth's surface.	1				
24. New moon is that phase of the moon when the moon is not visible from the earth since the illuminated half is facing away from the earth, that is the moon is between the earth and the sun.			1		

TABLE XII (continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
		Major Theme			
25. Novae or supernovae are stars that have "exploded" and released an enormous amount of light. As this occurs the star also expands rapidly into the range of a "giant" star.			1		
26. As the planets Earth and Mars revolve about the sun, there are periods when they are close to each other on the same side of the sun and also periods when they are very far from each other on opposite sides of the sun. This phenomena is due to the different periods of revolution of the Earth and Mars. The Optimium period to send a probe to Mars would be when Mars is closest to Earth.	1				
27. An orbit of a satellite is its path around the earth, moon, sun, or some other body in space.	4		2		
28. Orbiting the earth pertains to the path taken by a satellite as it travels around the earth.	1				
29. The period of rotation of the moon (the time required to rotate completely on its axis) is equal to its period of revolution around the earth. For this reason the same side of the moon always faces the earth. The moon rotates once on its axis as it revolves once around the earth.			2		
30. Period of revolution of a satellite is the time required by a satellite to make one complete pass or completely encircle the earth.	3		1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
31. Planets are large bodies that revolve around the sun, receive their light from the sun, and reflect some of this light into space thus becoming visible.	1		1		
32. A polar orbit is a path taken by a satellite that passes over both the North and South geographic poles and forms a right angle to the equator.	6				
33. Quasors or quasi-stellar sources are sources of tremendous energy found in space that may produce energy by an entirely unknown method.			2		
34. Radiation from outer space consists of radiant energy in the form of waves or particles traveling at or near the speed of light that require no medium for transmission emitted from bodies in outer space.			1		
35. Radio astronomy is the study of space and its contents by means of electromagnetic radiation, usually in the frequency range of radio waves, emitted by sources in outer space.			2		
36. Radio telescopes are used to detect radio frequency range electromagnetic radiations from outer space.			1		
37. A natural satellite is a heavenly body that revolves around a larger body as a planet. It is commonly called a moon.			2		
38. A man made satellite is an object intended to orbit the earth, moon, or other celestial body. It may contain data collecting instruments.	32				

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
39. Solar flare activity is a sudden and temporary outburst of energy from a small area of the sun's surface that is usually directly observable only as increased emission of a few spectral wave-lengths.	2				
40. Solar winds are intense concentrations of radiation in space as the result of solar flares or disturbances on the sun's surface.	1				
41. A stationary orbit refers to the situation when the period of revolution of a satellite around the earth is equal to the period of rotation of the earth and the orbit of the satellite is concentric to the earth's equator. When this condition exists, the satellite appears to be stationary or remain in one spot when viewed from some reference point on earth.	7				
42. Sunspots are spots that appear from time to time on the surface of the sun. They are due to major disturbances on the sun's surface and are visible only through a telescope. These sunspots are associated with solar flares which are sudden and temporary bursts of energy from the sun.			2		
43. Superior conjunction is an apparent coincidence of two celestral bodies in the same plane of the zodiac.			1		
44. A three-orbit flight requires three complete revolutions around the earth.	1				

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
45. Van Allen radiation belt consists of a belt of intense ionizing radiation that surrounds the earth in the outer atmosphere and extends into space to a distance of about 55,000 kilometers.	1				
Sub Totals	94		33		
III. BIOLOGY					
A. Morphology and Anatomy					
1. An artery is one of the tubular branching vessels that carry blood from the heart to the various parts and organs of the body.					1
2. The axilla is the cavity beneath the junction of the arm and shoulder more commonly called the armpit.					1
3. The bowel is a section of the intestine of man.					1
4. Cardio-vascular system pertains or relates to the heart and blood vessels.			1		1
5. A carotid body is a mass of tissue located near the large carotid arteries (the large arteries on either side of the neck which supply blood to the head).					1
6. Cartilage discs are tough elastic tissues between the vertebrae.					1
7. The central nervous system is that part of the nervous system, which in vertebrates, consists of the brain and spinal cord to which sensory					

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
impulses are transmitted and from which motor impulses pass out and which supervises and coordinates the activity of the entire nervous system.			1		1
8. The cornea is the transparent membrane on the exterior surface of the eye. The pupil is located in the center of the cornea.					1
9. Endocrine glands secrete hormones directly into the blood stream.			1		
10. The epidermis is the outer layer of skin.					1
11. Genito-urinary tract refers to the sex organs and the urinary system.					1
12. The human ear is used to catch and convert sound waves to nerve impulses. The external part of the ear collects the sound waves and channels them into the auditory canal. The canal is closed at its inner end by the eardrum. The middle ear contains three tiny bones which connect the eardrum to the inner ear. These tiny bones amplify the sound impulses in the inner ear and transmit these to the nerve endings that receive the sound impressions and convert them to nerve impulses. Damage or malformation of these tiny bones of the middle ear can cause loss of hearing.					1
13. Ischial tuberosities are protuberances on the anterior portion of the superior ramus; a slender process of the ischium bone.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
14. Intra-uterine means within the uterus.					1
15. Ligaments are bands of tissue holding bones together or organs in place.					1
16. Morphologically identical means to be identical in structure.					1
17. The olfactory nerves are the special nerves for smell located in the nasal passages.			1		
18. The pituitary gland is a small, vacuolar endocrine gland attached to the infundibulum of the brain. It interacts with other endocrine glands.					3
19. The plasma of the blood is the fluid part of the blood and differs from the serum in that it contains the antecedent substance of fibrin in addition to the constituents of serum.					1
20. Polyps are fingerlike growths on the inner surface of the large intestines.					1
21. Procreation glands are the sex glands (those glands used for reproduction.)					1
22. The thyroid is a large ductless gland in the neck which releases a hormone, thyroxine, which affects the basal metabolism rate of the body.					2

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
23. The thoracic duct is the main lymph channel in the chest which collects lymph from the organs in the chest and abdomen and empties into the large subclavion vien at the left side of the neck.					1
24. Vertebrae are the bones of the neck and back.					1
Sub Totals			4		25
B. Physiology					
1. Amino acids are nitrogenous organic compounds which represent the end products of protein hydrolysis. From amino acids the body resynthesizes its proteins.					1
2. An anti-coagulant in the blood prevents the blood from clotting, thus promoting rapid escape of blood from the vessels (hemorrhage).			1		
3. Anti-toxin is an antibody formed in the body as a result of the introduction of a toxin and is capable of neutralizing the specific toxin that stimulated its production. It is produced for medical purposes by the injecting of animals with gradually increased doses of toxin or toxoid. The resulting serum, extracted from the animals is used to counteract the same toxin in other individuals.					1
4. Basal metabolism is the metabolism rate of an organism in the fasting and resting state when it uses just enough energy to maintain vital cellular activities.			1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
5. Carbohydrates are chemical substances composed of carbon, hydrogen, and oxygen such as sugars and starchs and are utilized in the body as a source of energy.					1
6. Cholesterol is a fat like substance which has a tendency to accumulate in the arteries if not adequately broken down in the body.					2
7. The coagulation time of the blood is the time it takes for the blood to clot.					1
8. Enzymes are catalytic substances manufactured by living cells that have a specific action in promoting a chemical change.	1		1		
9. Endocrinological changes involve changes in the endocrine glands and/or their secretion of hormones into the blood stream.					3
10. Glucose is one of the simple sugars used by the body for energy.					1
11. Green algae are able to carry on the process of photosynthesis and thus use carbon dioxide and release oxygen in the presence of sunlight.			1		
12. Green plants, through the process of photosynthesis, utilize the carbon dioxide of the air and return oxygen to the air.			1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
13. A growth hormone is a chemical substance that regulates the growth rate of an organism.					2
14. Homing behavior is the ability of animals to find their way back if displaced from their homes.			1		
15. Hormones are specific organic substances produced in the cells of the body, transported in the body fluid, and regulated specific activities in various parts of the body.	1		1		5
16. Instinct is an inborn tendency to behave in a way characteristic of a species.			1		
17. Lactic acid is a substance resulting from incomplete oxidation of food in the human body. When lactic acid accumulates in the body the person feels fatigued.					1
18. Low-calorie foods are used to help control the amount of fat that accumulates in the human body.					1
19. Menopause or change of life is the time in a woman's life when menstruation ceases.					1
20. Metabolism is the process in organisms by which protoplasm is formed from food and broken down into waste matter with the release of energy.	1				6
21. Molecular biology is the study of life processes in terms of chemical action.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
22. Nutrition is the sum of the processes by which an animal or plant takes in and utilizes food substances.					1
23. Oxygenate means to impregnate or combine with oxygen.					1
24. Oxygen debt occurs when the level of oxygen in the blood is below that required for proper metabolism.					1
25. Pavlov's conditioned reflex experiment was a study of reflex actions in dogs and ways in which they could be altered. He conditioned dogs to release saliva in response to a variety of stimuli which did not originally cause the dogs to secrete saliva.					1
26. Peristalsis are contractions in the intestines occuring in waves which propel the intestinal contents onward or backward in the case of reverse peristalsis.					1
27. Proteins, carbohydrates, vitamins, and minerals are chemical substances essential to the proper functioning of the human body.					2
28. Psychological set-backs are changes in the emotional state of an individual.					1
29. Reflex responses are acts, such as a movement, performed automatically and without conscious volition and are a consequence of a nerve impulse.			1		
30. A reflex action is an involuntary action due to the direct transmission of a stimulus to a muscle or gland.			1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
31. Systemic reactions are those reactions which effect the body as a whole.					1
32. Testosterone is a male sex hormone produced by the testes.					2
33. Thyroxine is a hormone produced by the thyroid gland.					1
34. A toxic substance is a poisonous substance.			1		
35. Toxoid is a poison which has become inactivated but which retains its ability to stimulate the formation of antibodies within the body.					1
36. Vibrating stimuli of the fingers means to excite the nerve endings of the fingers through the use of vibrations.	1				1
37. Vitamin D is necessary for the utilization of calcium by the human body.					1
38. A well-balanced nutritious meal consists of the proper amounts of those foods that supply an adequate amount of protein, carbohydrate, vitamins, and minerals.					3
39. A good variety of foods will provide the needed vitamins, making it unnecessary to take vitamin pills.					1
Sub Total	4		11		46

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
C. Diseases and Disorders					
1. Acne is a chronic inflammatory condition of the hair follicles and sebaceous glands of the skin usually involving the face, back, and chest.					2
2. An allergy is a hypersensitivity of the body to a specific substance (as pollen, dust, certain foods, etc.) or condition (as heat, cold, etc.).			2		4
3. An amebic infection is caused by an ameba which is a one-celled organism.					1
4. Angina is any disease marked by attacks of choking or suffocation.					1
5. Angina Pectoris is a pain in the chest, sometimes radiating to the left arm caused by a spasm of the cardiac muscle of the heart.					1
6. Asthma is a condition characterized by difficulty in breathing, recurring at intervals, accompanied by a wheezing sound, cough, and a sense of constriction of the chest. It is usually due to a hypersensitiveness to inhaled or ingested substances.					2
7. Bacillary dysentery is an inflammation of the large intestine caused by certain bacteria.					1
8. Brights Disease is an inflammation of the kidneys.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. Bronchial asthma is a disease characterized by difficulty in breathing due to a spasmatic contraction of the bronchi or wind pipe.			1		
10. Bubonic plague refers to a contagious disease, usually fatal, transmitted by fleas from infected animals, especially rodents.					1
11. Certain animals can act as carriers of a disease, that is, they may be infected with the disease or serve as a source of a particular disease. Insects, biting these carriers, may then transmit these diseases to other animals that they bite.					2
12. Chondrodystrophy is a birth defect characterized by imperfect bone formation resulting in dwarfs.					1
13. Chronic bronchitis is an inflammation of the mucous membrane of the bronchial tubes, usually of long duration.			1		
14. A chronic disease is of long duration and is characterized by slowly progressing symptoms.					1
15. Cirrohosis is an inflammatory disease of the liver associated with the replacement of liver cells by fibrous tissue which eventually obstructs the flow of blood through the liver.					1
16. Coronary thrombosis is a clotting of the blood in the coronary artery.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
17. Cystic fibrosis is a hereditary disease of infants and young children characterized by the presence of cysts and excessive fibrous tissue in glandular organs (such as the pancreas and lungs) and by excess mucous secretion which causes a blocking of respiratory passages.					1
18. A dermatologist is a medical doctor who specializes in diseases of the skin.					1
19. A detached retina exists when the sensory membrane that lines the back of the eye has become detached from the back of the eye.					1
20. Diabetes is a disease of the body caused by its inability to utilize ingested sugars.					1
21. Diverticulosis is an inflammation of a diverticulum, that is, an outpouching or sac branching from the bowel wall.					1
22. Emphysema is a condition in which the air spaces of the lungs are enlarged making breathing more difficult.					1
23. Encephalitis or sleeping sickness is a disease caused by a virus which produces an inflammation of the brain and is commonly transmitted to humans by the bite of the female Culex mosquito.					3
24. Several types of encephalitis exist, the mild St. Louis type and the more severe Eastern type.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
25. An epidemic disease is a disease that is prevalent and spreads rapidly among people in a community.					16
26. Epilepsy is a nervous disorder accompanied by periodic convulsions and loss of consciousness.					2
27. Erythroblastosis fetalis is an anemia of the newborn occuring when a mother is RH negative and develops antibodies against her unborn child who is RH positive.					1
28. A eunuch is a casterated man.					1
29. Fibrositis is the overgrowth of fibrous tissue due to an injury or inflammation in the area.					1
30. Gangrenous slough is a castoff layer or covering of body tissue which has decayed as a result of constricted blood supply.					1
31. Gastro-intestinal diseases are those relating to the stomach and intestines.					1
32. The germ theory of disease states that living organisms (such as bacteria, fungus, protozoa, etc.) are responsible for various diseases of human beings. The virus theory of disease states that viruses (complex protein molecules, having no nucleus, cytoplasm, etc.) are responsible for various diseases.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
33. Goitrongenic substances are those producing or tending to produce goiter.					1
34. Gonorrhea is a venereal infection which causes inflammation of the lining of the genital organs.					3
35. Gout is caused by an excess of uric acid in the blood caused by a failure in the metabolic process to eliminate this chemical substance in the body.					1
36. Gouty arthritis is an inflammation about a joint caused by excess uric acid in the blood.			1		1
37. Hardening of the arteries is caused by an excess accumulation of cholesterol in the arteries which results in a constriction in blood flow.					3
38. Heart-block is a disorder in the transmission of the heart beat from the atrium to the ventricle.					1
39. Hemorrhage is a very rapid discharge or loss of blood from a blood vessel.					1
40. Hemorrhoid is an enlarged blood vessel within the region of the anus.					1
41. A hernia is a protrusion of an organ, especially a part of the intestine, through a tear or hole in the wall surrounding the structure.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
42. Hyperthyroidism is caused by an overactive thyroid gland usually associated with a goiter.					1
43. The lack of the pituitary hormone results in a hypopituitary dwarf; a person who doesn't reach normal height.					1
44. Leukemia is a cancer of the blood which effects the white blood cells and blood-forming organs.					5
45. A malignancy is a tumor or growth which tends to invade the surrounding tissue and eventually causes death if not removed or destroyed.			2	1	
46. Malnutrition is a state of being undernourished or poorly nourished.					2
47. Meningitis is an inflammation of the membranes covering the brain and spinal cord and is caused by microorganisms.					1
48. Migraine headaches are severe headaches associated with spots before the eyes, nausea, and vomiting.					1
49. Mongolism is a form of idiocy caused by a specific defect in the structure of the chromosomes.					1
50. Oral cancer is a cancer of the mouth.					1
51. Paralysis is the loss of the capacity for movement or sensation in part or all of the body.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
52. Paroxysmal tachycardia is a condition which occurs when the heart beat periodically rapidly increases and decreases.					1
53. Peritonitis is an inflammation of the peritoneum; a membrane lining the abdominal cavity.					1
54. Pernicious anemia is a severe, often fatal form of anemia characterized by a decrease in the number of red blood cells, hemoglobin or both, resulting in a decrease in oxygen-carrying capacity of a given volume of blood.					2
55. Primary anemia is caused by an acute loss of blood in the body.					1
56. Protein deficiency refers to an inadequate amount of protein in the diet (a complex nitrogenous substance occuring in all living matter) to sustain good health.					1
57. Pyclonephritis is an inflammation involving the kidney and its outlet due to the action of bacteria.					1
58. A rachitical condition is an inflammation of the spine resembling or suggesting the symptoms of rickets.					1
59. The RH factor is a component of the blood which may be involved with destruction of the red blood cells of an unborn or new born infant.					1
60. Rheumatism is a painful condition of the joints and muscles.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
61. Sexual infantilism refers to a body which is underdeveloped sexually, that is, has not gone through adolescence.					1
62. Sickle Cell Anemia is an insufficiency of red blood cells and is characterized by the sickle shape of the red blood cells. It is a hereditary, chronic anemia characterized by a short life span of the red blood cells.					1
63. Stokes-Adams disease is a slowed heart action caused by heart block and is associated with attacks of fainting and convulsions.					1
64. Surgical adhesions result from the abnormal union of normally separate tissues by the formation of new fibrous tissue.					2
65. Syphilis is a communicable venereal disease; occuring in its earlier stages as primary syphilis and later locating in various parts of the body as latent syphilis. Latent sypnilis may cause servere body damage and its treatment is difficult.					3
66. Tetany is a disease characterized by intermittent muscular spasms chiefly in the extremities.					1
67. An ulcer is a break in the skin or mucous membrane, and is characterized by loss of surface tissue, is associated with slow healing, and may be infected with pus.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
68. Ulcerative colitis is a nonspecific inflammatory disease of the colon of unknown cause characterized by diarrhea, abdominal pain, and similar discomforts.					2
69. An underactive thyroid gland decreases the rate of metabolism of food, resulting in the accumulation of fat.					1
70. Venereal diseases such as syphilis and gonorrhea, usually acquired through sexual intercourse.					3
71. Vesicular exanthema is a disease of swine caused by a micro-organism most commonly found in raw garbage.			1		
72. Virus-induced tumors are masses of abnormal tissue growing in or on the plant or animal body, possessing no physiological function and characteristically unrestrained in growth and structure and believed to be caused by certain viruses.					2
73. Whiplash injuries occur when a body is rammed from behind, as in automobile accidents, when the head tends to snap back as the body moves forward rapidly. The snap causes ligaments to tear or stretch or may even damage the bones of the neck or back.					1
74. Within the general class of viruses which cause encephalitis are more specific types of strains differing in structure and producing a particular type of encephalitis with specific symptoms.					6
Sub Total			8	1	116

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
D. Diagnosis and Treatment					
1. An anesthetic is a chemical substance used to produce loss of sensation of pain and so permits painless surgical operations.					2
2. Antibiotics are those substances produced by some micro-organisms that are capable of destroying or weakening infections due to other organisms.					4
3. Antibodies are substances carried in the blood of animals which are capable of producing an immunity to a specific disease causing organism.					8
4. Antigens are those substances which stimulate the formation of antibodies or reacts with them.					1
5. Antihistamines are drugs that tend to counteract an allergic condition.					1
6. Antiseptic detergents are cleansing substances effective against bacteria and other substances that cause infection.					1
7. An anti-serum is an extraction from the blood of an animal and contains antibodies against a specific disease or organism.					1
8. Anti-viral substances retard or stop the spread of virus caused diseases.					2

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. Barbiturates and narcotics are sedatives, that is, they are drugs given to calm the nerves and decrease the state of excitement. Both may be habit forming.					1
10. A biopsy involves the surgical removal of tissue in order to diagnose a disease or disorder of the body by examination of the excised sample.					1
11. Blood types are determined by the presence of certain sensitivities or antigens of the red blood cells. If the blood types are incompatable, clotting and destruction of the red cells take place.					1
12. Chlorination involves the treatment of water or sewage with chlorine to destroy harmful organisms.					1
13. Constricting drugs are used to constrict the blood vessels to reduce the loss of blood due to hemorrhage.					1
14. Electrocardiograms are the tracings made by an electrocardiograph, an instrument which records the changes of electrical potential occuring during heartbeat. Electrocardiograms are used to determine and detect irregularities of the heart action.	1				1
15. Fluoride compounds have been found effective in reducing and preventing tooth decay.					1
16. A fluoroscope involves the use of x-rays (electromagnetic rays of great penetrating power) to penetrate selected portions of the body and form an image on a fluorescent screen.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
17. Freeze-dehydrated foods are first frozen and then the moisture is removed.					1
18. Glandular therapy involves the treatment of glands.					1
19. A heterograft is a graft of tissue taken from the body of another person.					1
20. A hysterectomy is the surgical removal of the uterus.					1
21. Immunity implies a resistance to a specified disease.					5
22. Immunization is the treatment of an organism for the purpose of making it immune or not susceptible to a subsequent attack by a particular pathogen.					6
23. Inoculation involves the process or act of injecting a vaccine or other substance into the body for the purpose of inducing immunity to a disease.					1
24. Irritant is some agent tending to produce irritation or inflammation in the body.					1
25. Krebiozen is a chemical substance with doubtful cancer curing ability.					1
26. The oral cytology smear technique involves scraping off some of the cells in the mouth and examining them under a microscope for diagnostic purposes.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
27. Orchidectomy is the surgical removal of a testicle.					1
28. Ovariectomy is the surgical removal of an ovary.					1
29. A pace-maker is an electronic device used to send electrical impulses to the heart to keep it beating in a regular pattern.					1
30. Pasteurization is the partial sterilization of a fluid at a temperature (131°-158° F) which destroys certain pathogenic organisms and undesirable bacteria.					1
31. A proctoscopic examination involves the use of an instrument to allow visual inspection of the rectum.					1
32. Radiation treatment consists of exposing the cancerous tissue to x-rays or alpha or beta rays.					4
33. Sedation is the inducing of a relaxed easy state by the use of drugs.					1
34. A smear is a sample of material such as blood spread on a glass slide for microscopic study.					1
35. Sterile bones have been made free of microorganisms.					1
36. Tracheotomy is a surgical incision into the trachea or windpipe.					1
37. Tranquilizers are chemical substances used to calm or quiet emotionally disturbed people.					4

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
38. A vaccine is a preparation of killed microorganisms, living attenuated organisms, or living fully virulent organisms that is administered to produce or artificially increase immunity to a particular disease.					13
39. Vaccination is the introduction into man or domestic animals of microorganisms that have previously been treated to make them harmless for the purpose of inducing the development of immunity.					2
40. The human body has a means of rejecting foreign substances, such as bone or skin, when transplanted to the body.					1
Sub Total	1				80
E. Genetics					
1. Chromosomes are bodies within a cell that contain the genes responsible for a child's inheritance of the Parents' characteristics.					1
2. Favorable heredity for long life implies acquiring through the process of heredity certain desirable traits that will enable that body to achieve a long life. Some of these traits might include immunity to disease, very efficient metabolism of food and respiration, etc.					1
3. Genes are the elements of the germ plasm serving as a specific transmitter of hereditary characteristics.					3

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
4. Genetic advice or code is a sequence of DNA components that dictates specified protein components which determine structural traits.					2
5. The genetic material of a cell refers to DNA components that dictate protein construction and hence determine structural traits			1		
6. Genetics is that branch of biology which deals with heredity and variations among related organisms and their evolutionary aspects.					1
7. Hereditary diseases are those diseases that are genetically transmitted from parent to offspring.					3
8. Heredity is the genetic transmission from parent to offspring of certain characteristics.					3
9. Hereditary factors control certain genetic characteristics passed along from parents to offspring such as rate of growth and height.					5
10. Inherit means to receive by genetic transmission.					3
11. A mutation is a sudden variation of some inheritable characteristic of a plant or animal.					1
Sub Total			1		23

TABLE XII (continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Major Theme Science	Nuclear Energy	Medicine
F. Taxonomy					
1. Bacteria are any of a large group of microscopic plants found in nature. They are unicellular. A relatively small group is pathogenic, that is, cause disease.			6		
2. The bovine family is the cow family.			1		
3. Citronella is a fragrant oil effective as a mosquito repellant obtained from citronella grass of Southern Asia.			1		
4. Crustaceans are invertebrates having a hard outer shell.			1		
5. Evolution is a process of development of a species from one state to its present state.			1		1
6. Fungi are plants that have no leaves, flowers, or green color, and reproduce by spores. They are chiefly saprophytic or parasitic.					3
7. Hyacinths are plants of the lily family with spikes of bell-shaped flowers.			1		
8. Hydrogenomonos is a genus of short rod-shaped soil bacteria capable of oxizing hydrogen to form water and use carbon dioxide as a source of carbon for growth.			1		
9. A legume is any member of the pea family and contains nodules on its roots which add usable nitrogen to the soil.			1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
10. Manatus or sea cows are large, plant-eating aquatic animals found in tropical waters.			1		
11. Microbes are very minute organisms such as bacteria.			1		
12. Tubercular bacilli are rod-shaped bacteria which cause tuberculosis.					1
13. Plankton are microscopic plants and animals found in bodies of water.			1		
14. Primate is an order of eutherian mammals including man, apes, monkeys, lemurs, and living and extinct related forms that are all thought to be derived from generalized arboreal ancestors. They are generally characterized by increasing perfection of binocular vision, specialization of the appendages for grasping, and enlargement and differentiation of the brain.			1		
15. A virus is a submicroscopic infective agent which may be responsible for some diseases.			3		19
Sub Total			20		24
G. Ecology					
1. Aerated soil is soil that has been exposed to air.			1		
2. Climatized means adjusted to a new and/or different environment.					1

TABLE XII (continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
	Major Theme				
3. A controlled environment is one in which the conditions surrounding an organism such as the amount of heat, light, moisture, and pressure are controlled.			1		
4. A cover crop is any crop used to protect the soil from erosion.			1		
5. An epidemic of beetles is a prevalent and wide spread concentration of these insects in such large numbers as to constitute a threat to crops and animals.			1		
6. Environment pertains to all the conditions surrounding and effecting the development of an organism or an object.			2		
7. For life to emerge on a distant planet, all the conditions that affect the development of an organism must be available. This is referred to as a favorable environment for life.			1		
8. Habitat refers to a region in which a plant or animal naturally lives.			1		
9. Herbicides are chemical substances used to kill weeds.			1		
10. Inoculated legume seeds contain nitrogen fixing bacteria which carry on the process of nitrogen fixation.			1		
11. Insecticides are substances used to kill insects.			1		
12. Migration of birds involves the instinctive movement of birds from one region to another usually associated with the change in season.			1		

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
13. Nitrogen balance pertains to the amount of useable nitrogen in the soil. To insure proper plant growth a sufficient amount of useable nitrogen must be present in the soil for these plants.			1		
14. Palatable water is water agreeable to taste and pleasing to drink.			1		
15. A parasite is a plant or animal that lives on or within another plant or animal at the expense of the host.					4
16. Pollution is the contamination of air and water by various substances such as smoke, dust, salt and chemical substances.			2		
17. Potable water is water pure enough to drink.			1		
18. Smog is a mixture of smoke, fog, other waste gases, and solid particles that causes a severe air pollution problem.			1		1
Sub Total			18		6
H. Developmental Biology					
1. Congenital defects are defects existing at birth acquired during development in the uterus.					3
2. Congenital syphilis is that form of syphilis with which a child is born having acquired it from the mother during development in the uterus.					3

TABLE XII (continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
3. Differentiation of cells refers to the process of distinguishing or making cells different. As a result of this process the cells of an organism become more complex and specialized.			1		
4. Embryos are organisms in the early stages of growth and differentiation before birth or hatching.			1		1
5. The life cycles of the frog and toad involve the laying and fertilization of eggs in the water, the hatching of the eggs into free-swimming animals called tadpoles which have gills, and the later metamorphosis or change to adults which have lungs.			1		
Sub Total			3		7
IV. CHEMISTRY					
1. An acid is a corrosive substance which can attack the calcium compounds of the teeth.					1
2. Acid solutions have a sour taste, react with active metals liberating hydrogen gas, and produce the hydronium ion in solution.			1		
3. Adsorption is the process in which a substance collects a thin layer of molecules of a gas or liquid on its surface.			1		
4. An antifreeze agent is a chemical substance which, when added to water, lowers the freezing point of the mixture.					1

TABLE XII (continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
5. An atom is the smallest particle of an element that has all the properties of the element. A molecule is the smallest particle of a compound that can exist. Molecules are composed of atoms.			1		
6. Auto-combustion of a fuel means the fuel is hot enough to spontaneously ignite when mixed with an oxidizer.	1				
7. Charcoal is a very effective filtering substance. It is used in the purification of water it readily absorbs gases and liquids on its surface, thus removing odors, colors, etc. from water.			2		
8. A compound is substance composed of two or more elements chemically combined.					1
9. A condenser is a device for changing a gas, such as steam, into a liquid by removing heat energy from the gas.			1		
10. Detergents are any of a large number of synthetic water-soluble or liquid organic surface - active agents used for washing.			1		
11. The electrolysis of water involves the breaking up of water molecules into constituent elements (hydrogen and oxygen) by means of an electric current.			1		
12. An electron is a negatively charged particle with little mass found in an atom.			2		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
13. A homogeneous mass has uniform structure or composition throughout.					1
14. Homogenized means to reduce the particles to such a small uniform size that they become distributed evenly throughout the medium.					1
15. Hydrogen is chemically united with oxygen in the compound water.			1		
16. Hydrogen is the lightest element and appears to be the building material of the universe.			1		
17. Lead is an excellent shield against radiations emitted by radioactive substances.				1	
18. Inorganic elements or substances are derived from other than plant or animal material. They do not contain hydrocarbons but may contain some relatively simple carbon compounds.			1		
19. Ionizing radiations such as x-rays and gamma rays break up gas molecules into electrically charged fragments. Such charged fragments are called ions and the gas is said to be ionized. Such a gas is able to behave as a conductor of electricity.			1		
20. Metals are elements that are capable of conducting an electric current.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
21. Metal sulfides are chemical compounds composed of a metal combined with sulfur and can be converted to metal sulfates which are chemical compounds composed of a metal combined with the sulfate group (SO_4) by the process of oxidation. Most metal sulfides are insoluble in water whereas most of the metal sulfates are soluble.			2		
22. Molecule is the smallest portion of an element or compound that retains chemical identity of the substance. It usually consists of a chemical union of two or more atoms.			1		
23. A neutron is an electrically neutral nuclear particle that has a mass of one atomic mass unit. The mu meson is a nuclear particle that has a negative charge and a mass about 200 times the mass of the electron.			1		
24. Nitrogen is a colorless, odorless, gaseous chemical element making up nearly four-fifths of the earth's atmosphere and is essential to plant growth.			1		
25. Organic matter is like, or derived from living organisms and always contains the element carbon.			2		1
26. Oxidation is a process in which a substance unites chemically with oxygen.			2		
27. An oxidizer is a substance that unites with the fuel in a rocket in the process of burning.	1				
28. Polycyclic hydrocarbons are molecules containing hydrogen and carbon that contain two or more groupings of atoms in the form of rings or closed chains.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
29. Propellants are materials capable of propelling a rocket into space.	1				
30. Saturation of a salt solution means that the solution holds all of the dissolved salt it is capable of holding at that temperature.			1		
31. Silicon is a nonmetallic element occuring abundantly in a combined form in nature.			1		
32. A solution is a mixture of one substance (solute) dissolved in another substance (solvent).					1
33. A solvent is that part of a solution in which the solute is dissolved.					1
34. According to the quantum theory an electron in an atom can only have certain particular energy levels which are integral multiples of the smallest unit. The lowest energy or "ground state" of the electron is the most stable energy level.			1		
35. Sulfur is a pale-yellow nonmetallic chemical element. Sulfur and compounds of sulfur are found in abundance in areas of volcanic activity.	1				
36. Sulfur dioxide plus water from the air forms a mist of sulfurous acid which is highly toxic and corrosive.			1		
37. Titanium is a metallic chemical element with a very high melting point and very strong structural characteristics.	1				

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
38. Water vapor, a gas, is composed of molecules of water. Each molecule of water is composed of two atoms of hydrogen and one atom of oxygen that are chemically united.			1		
39. A wetting agent is any substance that promotes the spreading of a liquid on a surface or its penetration into a material.					1
Sub Total	5		30	1	9
V. COMPUTER SCIENCES					
1. Automation exists when the operation of an apparatus is automatically controlled or when a system of mechanical or electronic devices take the place of human functions of observation, effort, and decision.		4			
2. A computer is a specialized electronic calculator designed to perform rapid mathematical operations.		6	1		
3. A computer program consists of a specific set of instructions to be followed by the computer.		1			
4. Cybernetics pertains to the comparative study of electronic calculating machines and systems and the human nervous system.		1			
5. Simulated human learning by a computer implies that the computer will be able to imitate or characterize human behavior.		1			
Sub Total		13	1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
VI. ENGINEERING					
1. Fallout shelters are protected areas in which the public can seek protection from atomic fallout if a nuclear explosion takes place.				1	
2. A tanker's boom is a special refueling line that allows aircraft to be refueled while in flight.	1				
Sub Total	1			1	
VII. GEOLOGY					
1. Carbonate rock contains salts of carbonic acid and releases two gases, carbon dioxide and carbon monoxide, when heated intensively.				1	
2. A driftless area is a non-glaciated area.			1		
3. Erosion is the wearing away of the earth's surface by chemical and physical means (such as rain, snow, running water, freezing, gravity, etc.)	2		2		
4. The absence of an atmosphere on the moon will eliminate erosion caused by wind, rain, snow, etc., that is, those erosive factors caused by weather.	1				
5. A fault is a break or fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.			1		
6. Fossils are the preserved remains of plants and animals of some previous geological age.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
7. Fossil fuels, such as coal, oil, and natural gas were formed by the depositing of pre-historic plant and animal materials on the earth's surface and their gradual conversion to these fuels over a long period of time.				1	
8. The moho is a region in the earth located about three miles beneath the ocean floor or about 25 miles beneath the continental surface in which there is a change in the nature of the earth materials from those of the earth's crust to those of the subjacent mantle.			1		
9. An ore is a combination of minerals from which a metal or metals can be profitably extracted or separated. *Low grade ores* contain such a small amount of metal that they are not economically useable.			2		
10. An out crop is the exposure of a mineral on the surface of the ground.			1		
11. Radiometric dating of fossils is a means of determining the age of plant or animal fossils by determining the amount of radioactive carbon found in the fossil and calculating the time it has taken to reach that state at a known decay rate.			2		
12. Pumice is a kind of volcanic glass that is so full of minute cavities that its overall density is less than that of water.	1				
13. Seismic detection involves the detection and measurement of the earth's movements such as earthquakes, blasts, or other diastrophisms.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
14. Seismology is a study of movements of the earth's crust as in earthquakes.			2		
15. Shield volcanoes form domes composed almost entirely of lava. The eruptions are largely quiet and form gently sloping shield shaped domes.			1		
16. A stratified surface is an arrangement of the sedimentary rocks into layers or divisions often marking the circumstances of deposition.	2				
17. A terminal moraine is an accumulation of earth, stones, etc. carried by a glacier and deposited when the glacier receded.			1		
18. Volcanic fissures are cracks or clefts in the earth's surface through which molten rock and sulfurous gases escape.	2				
19. A watershed is the catchment area or drainage basin from which the waters of a stream or stream system are drawn.			1		
Sub Total	8		17	2	
VIII. METEOROLOGY					
1. Atmospheric tides are vast movements of the earth's atmosphere caused by the gravitational attraction between it and the moon and sun.			1		
2. Cloud patterns or formations are associated with weather conditions.	1				

TABLE XII (Continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Major Theme Science	Nuclear Energy	Medicine
3. Cloud seeding or "nucleating" involves the use of solid chemical substances such as silver iodide to serve as tiny nuclei on which water vapor can condense and form raindrops.			2		
4. Meteorological pertains to studies of the weather and climate.			1		
5. Monsoons are seasonal winds of the Indian Ocean and South Asia which carry large amounts of moisture to the land areas over which they blow.			1		
6. The nucleus of a raindrop is the fragment of solid material which composes the center of the raindrop.			1		
Sub Total	1		6		
IX. OCEANOGRAPHY					
1. A bathyscaphe is a navigable submersible ship that is used for deep sea exploration, has a spherical watertight cabin attached to its underside, and uses gasoline for lift and shot for ballast.			1		
Sub Total			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
X. PHYSICS					
A. Electricity - Magnetism					
1. Anti-radiation covering is used on airplanes flying at very high altitudes to help protect the surface of the aircraft from intense radiation at this altitude.	1				
2. Charles Coulomb, a French physicist, found by experimental methods that the force between electrically charged spheres varies as the inverse square of the distance between them.			1		
3. A dipole antenna is a straight radiator, usually fed from the center, and producing a maximum of radiation in the plane normal to its axis. The length specified is the over-all length. It is also called a Hertz dipole in honor of its inventor.			2		
4. Direct current generators are capable of converting some other forms of energy into direct current electricity.			1		
5. As the temperature of most electrical conductors is lowered its electrical resistance is reduced.			1		
6. The electromagnetic energy or radiation from the sun is able to exert enough force upon a space satellite to slightly alter its course.	1				

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
7. The electromagnetic spectrum is a continuous range of frequencies of radiations from gamma rays to radio waves. The physical nature of radiation is the same throughout the entire range; in all sections it has the same velocity and electromagnetic nature. The only differences from one part of the spectrum to another are in frequency and wave length.			1		
8. The electron microscope uses a beam of electrons in place of light to magnify small objects. It forms the image of the object on a screen like a television screen or on photographic film.			1		
9. Faraday discovered that as a conductor cuts magnetic lines of force an electric charge accumulates or moves in the conductor. If a wire loop is used an electric current forms in the loop. This principle is known as electromagnetic induction.			1		
10. Frequency is the number of complete oscillations per second of the electric or magnetic component of an electromagnetic wave.			1		
11. Helical beam antenna is a non-directional antenna.	1				
12. Image intensification in an electron microscope is accomplished by an electron tube circuit in which amplification is secured by secondary emission of electrons. Primary electrons (the image) are accelerated by application of a high potential and made to strike a good secondary emitter where more electrons are produced by the impact. This process is repeated thus greatly intensifying the electron image.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
13. A kilowatt is a unit of power equal to 1000 watts.				1	
14. A kilowatt hour is a unit of electrical energy or work equal to that expended in one hour at a steady rate of one kilowatt.				1	
15. Line-to-line scan basis in television involves the transmission of a picture by separate horizontal lines usually consisting of 525 separate lines repeated 30 times each second. The television receiver sweeps these lines across the picture tube reconstructing the complete picture.	1				
16. The strength of a magnetic field produced by an electromagnet increases as the amount of electric current through the electromagnet increases.			1		
17. Magnetic fields are said to exist in that space surrounding a magnetic body in which the magnetic forces due to that body are sensible.	1		1		
18. One of the theories pertaining to the cause of the magnetic field of planets involves the movement of liquid magnetic materials in the hot core of the planets.			1		
19. When a magnetic object is brought near an iron object the lines of force surrounding the magnet cause the iron object to become temporarily magnetized. The iron object is said to be magnetized by induction.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
20. Maser stands for "microwave amplification by stimulated emission of radiation." A molecule can exchange energy with the electromagnetic radiation field only in discrete amounts since molecular energy is quantized. If molecules can be raised to a higher energy level and then made to discharge simultaneously to a lower level an amplification of radiation takes place.			1		
21. A megawatt is a unit of electrical power and equals one million watts.				1	
22. Nickle cadmium batteries can be recharged many times.	1				
23. Oersted discovered that a wire carrying an electrical current is surrounded by a magnetic field.			1		
24. Ohm's Law is stated as--the electric current in a conductor is directly proportional to the potential difference (voltage) between any two points in the conductor and inversely proportional to the resistance of the conductor.			1		
25. An oscillator is a device for producing an alternating current the frequency of which can be varied by varying the current to the grid of a vacuum tube. The oscillator is the heart of a radio transmitter since it generates the high frequency carrier signal essential for this type of communication.			1		
26. Over-the-horizon radar involves sending out radiowaves and bouncing them off the ionosphere to some distant object beyond the horizon which in turn reflects the radiowaves back to the ionosphere which reflects them back to a receiver or detector. This device allows not only the detection of the object but also a calculation of its distance.	3				

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
27. Polarization involves the blocking of electromagnetic radiations moving in all directions but one perpendicular to the line of propagation to allow waves vibrating in one direction only to be transmitted through the polaroid filter.			1		
28. Polarized radio signals vibrate in only one plane.	1				
29. Radar is a detecting and ranging device that emits radio waves and receives them after they have been reflected by some object, thus allowing the distance and position of the reflecting object to be calculated.	2		1		
30. A radiometer is an instrument for detecting and measuring the intensity of some electromagnetic radiations.			1		
31. An R. F. Signal is an electromagnetic radiation in the radio frequency range.			1		
32. Ultraviolet pertains to that part of the electromagnetic spectrum just beyond the violet end of the visible spectrum.			1		1
33. VHF is an abbreviation for very high frequency radio waves.			1		
34. The wavelength of electromagnetic radiation is the distance measured in the direction of progression of the wave, from a given point on a wave to the next point in the same phase of the wave.			1		
35. X-rays are electromagnetic radiations of extremely short wave length and possess enough energy to penetrate certain substances to varying depths.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
36. X-ray opaque dyes are chemical substances that do not allow x-rays to pass.					1
Sub Total	12		26	3	2
B. Heat					
1. A calorie is a unit for measuring quantity of heat. It is used to describe the heat or energy producing value of food.					2
2. Heatshields are used to protect a satellite from the intense heat caused by air friction as it re-enters the dense atmosphere of the earth.	2				
3. The heat transfer rate involves a study of the heat dissipation from the surfaces of aircraft in flight.	1				
4. Infra-red is the region in the electromagnetic radiation spectrum made up of wave lengths longer than those of visible light.			1		
5. An infra-red radiometer is an instrument designed to detect those invisible rays just beyond the red of the visible light part of the spectrum.	2				
6. A microwave radiometer is a device used to detect nuclear blasts by measuring the heat liberated by the blast either above or below the ground.				1	
7. Liquid nitrogen is used in low temperature research since its temperature is near--459.7° F.			1		
8. The Rankine-Cycle power source is a nonreversible heat engine cycle differing from the Carnot cycle in that it has no compression.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. The Stirling-cycle engine is an air engine using a regenerator; its indicator diagram has two isothermals and two lines of constant volume.			1		
10. Supercooled water vapor is water vapor at a temperature below its condensation point or even its freezing point. It does not liquify or solidify due to the absence of starting materials to form the nucleus of the raindrop, snowflake, or hailstone.			1		
11. Thermal efficiency is the ratio of the heat utilized by a heat engine to the total heat available in the fuel being consumed.			1		
Sub Total	5		6	1	2
C. Mechanics					
1. Rockets and satellites in space are propelled or maneuvered by using the principle of action-reaction. As the hot gases produced by the rapid combusion of either solid or liquid fuels escape from the rocket engines a force of equal magnitude to that of the escaping gases but acting in an opposite direction propels the rocket forward. In space, periodic spurts of nitrogen gas from tiny jets are used to maneuver satellites in their orbits.	5				
2. Airflow measurements involve a study of the movement of air past the surfaces of an aircraft in flight.	1				
3. An altimeter is a device used to measure the altitude of an airplane or other vehicle in the atmosphere.	1				

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
4. Apogee is the highest point reached by an object in a path.	1				
5. Atmospheric drag on a satellite is caused by the friction between the satellite and the thin air in the region of its orbit around the earth. This drag has a tendency to reduce the orbiting speed.	1				
6. Atmospheric pressure refers to the force exerted by a column of air extending to the outer most limits of our atmosphere upon a unit surface area.			1		
7. Ballistic apogee point is the highest point or the point farthest from the earth in the path of a missile fired from the earth's surface.	1				
8. Boundary layer noise is a result of the retarded rate of flow of a fluid (as air) close to the surface of a body (as an airplane). The retardation is greatest close to the surface of the body and is due to the viscosity of the fluid and its adhesion to the surface.	1				
9. Buoyancy is the upward force exerted upon a body immersed in a fluid.			2		
10. Centrifuges are devices used to increase the force acting upon a body to many times the normal gravitational force through the use of high speed circular motion.					1

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
11. The density of a substance is the weight of a specific volume of the substance. Density is usually expressed in grams per cubic centimeter or pounds per cubic foot and is found by dividing the weight of an object by its volume.	2		3		
12. Diffusion is a process in which molecules of gases and liquids spread out or move randomly in any direction.			1		
13. In the theory of relativity, Einstein stated that light rays should be bent in the vicinity of a gravitational field. Experimental evidence gained as a result of studying solar eclipses seems to support this theory. Einstein also theorized that as a light source of stable frequency moves rapidly toward or away from a distant observer the frequency of the light changes due to the Doppler effect.			1		
14. Friction is the resistance offered to the relative motion of one body that is sliding, rolling, or flowing over another.			1		
15. When objects from outer space enter the earth's atmosphere at a high rate of speed the friction between the air and the object causes enough heat to destroy the object.	1				
16. The heat developed as two stones are struck together or two sticks are rubbed together is due to friction.			1		
17. The fulcrum of a balance is its pivot point.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
18. Gaseous diffusion through a fine membrane involves the passage of small gas molecules through the minute holes of the membrane; larger molecules do not pass through because the "holes" in the membrane are too small.			1		
19. Gravitational fields exist about all material objects. The intensity of the gravitational attraction between objects within this field decreases with distance between the objects and increases with the mass of the objects.	1				
20. As a satellite, traveling at a high rate of speed enters the earth's dense atmosphere, the friction between the satellite and the air causes a "heat build up" on the satellite's surface.	1				
21. Hot air is less dense than cold air and is therefore forced up by the colder denser air when both exist.			1		
22. An intercontinental ballistic missile is a rocket propelled missle designed to deliver an explosive warhead to a distant target. These missiles are not designed to place an object in orbit but merely to follow a calculated trajectory.		1			
23. International date line is a hypothetical line on the earth's surface coinciding with the 180th. meridian and designated arbitrarily as the place where each calendar day begins.	4				
24. Levers are simple machines used to transmit and/or modify forces or motion.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
25. Lift is the upward force formed as a result of the passage of air over the surfaces of an airplane.			1		
26. Mass is a measure of the quantity of matter.			1		
27. A parabolic arc is the name given to a curve formed by the intersection of a cone with a plane parallel to the axis of the cone.	1				
28. Rectilinear propagation refers to the motion of a particle in a straight line.			1		
29. Pitch is the term applied to the motions of a craft about a horizontal axis perpendicular to the direction of motion of the craft.	1				
30. Retrorockets are rockets that are fired in a direction opposite to the direction of motion of the vehicle carrying them.	3				
31. Roll is the term applied to the motion of a craft about the longitudinal axis of the craft.	1				
32. A soft-landing of a space vehicle occurs when through the use of parachutes and/or retrorockets, the vehicle lands on a surface with very little impact.	1				
33. Sonic boom is a loud explosion-like noise produced by objects traveling faster than the speed of sound. Its intensity is affected by the speed of the object and its altitude above the earth; it decreases as the object attains a greater altitude and increases as the object increases in velocity in supersonic flight.					2

TABLE XII (Continued)

Prerequisite Knowledge	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
34. Suborbital flights of vehicles follow a path resembling a parabolic arc rather than going into orbit.	3				
35. A supersonic object is any object traveling faster than the speed of sound.	4				
36. Surface tension is a condition that exists at the free surface of a body (as a liquid) by reason of intermolecular forces. It resembles an elastic skin under tension.			1		
37. Telemetering instruments are used to measure specific quantities, transmit the results to distant stations, and record the value of the data.	1				
38. Thrust is the forward force produced by the gases escaping from a rocket and is commonly measured in pounds.	5				
39. A trajectory is a curved path of an object traveling through some medium or space.	3				
40. Weightlessness is a condition of equilibrium in which all forces acting upon an object are balanced.so the net force is zero. A body in free fall is weightless. An object in orbit in space is weightless.	4				
41. Yaw is the term applied to the motion of a craft about a vertical axis perpendicular to the direction of motion of the craft.	1				
42. As gases are heated they tend to expand with a resultant increase in pressure if confined.				1	
43. If a liquid or gas is exposed to a near perfect vacuum they often seem to explode; the gas may expand rapidly and the liquid may vaporize rapidly.			1		
Sub Total	49		19	1	3

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
D. Nuclear and Atomic Physics					
1. It is believed that a particle with half-integer spin (fermion) can be destroyed only with the simultaneous creation or destruction of another fermion. The process resulting in the simultaneous disappearance of two particles is known as annihilation. At present this process has been observed for electrons, protons, and neutrons. One of the disappearing particles must be an "anti-particle" with respect to the other (example; an electron and a positron which may be annihilated are each other's anti-particles). The annihilation process always satisfies the general conservation laws for the total energy, momentum, angular momentum, and electric charge of the annihilated pair.			1		
2. Atoms vibrate at a fairly consistent frequency within a crystal at some specified temperature. This constant frequency of vibration can then be used as a timing device.			1		
3. A chain reaction is the self-propagating fission of atomic nuclei continued by the further action of one of the products; in the fission of a uranium nucleus by a neutron the release of more neutrons causes additional fissions.				1	
4. Criticality of a nuclear reactor is that point or condition at which enough fissionable material is present to sustain a chain reaction.				1	
5. Fissionable material is capable of being split (fissioned) in a nuclear reactor or nuclear bomb into simpler elements.				1	

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
6. The fission products of a nuclear reaction consist of radioactive isotopes of various elements and other charged particles that result from the splitting of the nucleus of an atom.				1	
7. Geiger counters are electronic devices used for detecting and measuring the intensity of radiation emitted from a radioactive substance.			1		
8. "High-yield" nuclear explosions are those that liberate or create an enormous amount of radioactive fallout.				1	
9. Iodine 131 is a radioactive isotope of iodine formed as a result of nuclear explosions.				1	
10. An effective insulator against radioactive substances is one that will stop or absorb most of the harmful radiation emitted by the radioactive substance.				1	
11. The life-span of an atomic waste product is the time required for that product to lose most of its harmful radiation.				1	
12. A light water reactor is one in which ordinary water is used as both the cooling agent and the moderator. This differs from the heavy water reactor which uses deuterium oxide as the moderator.				1	
13. The milicurie is a unit of measure of amount of radiation.				1	
14. Neutrinos are unchanged elementary particles with a zero rest mass.			1		

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
15. A neutron is a particle found in the nucleus of atoms. It is electrically neutral and has a mass of one atomic mass unit.			1		
16. Nuclear fission - During the process of nuclear fission great amounts of energy are emitted as a result of the splitting of atomic nuclei and the residue or products of the fission process are radioactive.				1	
17. Nuclear fusion is the process of releasing energy through the uniting of the nuclei of light chemical elements to form nuclei of heavier elements.			1		
18. Nuclear reactors are devices in which a chain reaction of fissionable material is initiated and controlled.				2	
19. The nucleus of an atom is the dense center part of the atom around which the electrons orbit.			1		
20. Radiation hazard implies the presence of harmful radiations such as those emitted from radioactive isotopes, accelerators, etc.				1	
21. Radioactive Argon 31 is an isotope of the element argon which emits radiations such as alpha, beta, or gamma particles or rays.			1		
22. Radioactivity is the term used to describe a property possessed by some elements which spontaneously emit alpha or beta or gamma rays or particles.				1	

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
23. Radioactive decay is the process of disintegration of radioactive materials resulting in the formation of different elements or isotopes of elements and is usually accompanied by the emission of alpha, beta or gamma radiations.				1	
24. Radioactive fallout is the accumulation of radioactive substances in the atmosphere as the result of a nuclear explosion and the slow descent of these materials to the earth's surface.				3	
25. Radioactive isotopes are different forms of the same element, differing in the number of neutrons contained in the nucleus and emitting radiations in the form of rays or particles as the result of the disintegration of the unstable nucleus.			1	2	1
26. Short-lived fallout pertains to those radioactive substances produced by a nuclear explosion which are radioactive or emit radiation for only a short period of time.				1	
27. A thermal reactor is an apparatus in which a chain reaction of fissionable material is initiated and controlled for the production of a known quantity of heat.				1	
Sub Total			9	23	1
E. Sound and Light					
1. A fluorescent dye is a chemical substance capable of producing light when acted upon by radiant energy.			1		
2. The laser is a device that utilizes the electrons within atoms for amplifying or generating electromagnetic waves in the visible region of the spectrum.			1		1

TABLE XII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
3. The magnification power of a microscope is a measure of its ability to enlarge the apparent size of some object.			1		
4. Opaque substances do not transmit light.					1
5. Photon radiation is the emission of light quanta. The velocity of light in free space is constant, 186,000 miles per second.			1		
6. Rainclouds become darker as they accumulate more moisture in the form of tiny water droplets. These droplets absorb and reflect the light, thus permitting little light to pass through the cloud.			1		
7. Reflection is the process by which light or other forms of electromagnetic energy bounces off of various surfaces.			1		
8. Refraction of light involves the bending of light waves as they pass from one medium into another of different density.			3		
9. The resolution of a camera refers to its ability to render visible the separate parts of an object. A camera with high resolution produces an image that is sharp and full of detail.	1				
10. Solar panels are a series of solar cells used to convert radiant energy from the sun, usually visable light, into electricity.	3				
11. Sonar means sound navigation ranging and is a method of detecting objects by bouncing sound waves off of the object.				1	
Sub Total	4		9	1	2

TABLE XIII

Number of Items of Prerequisite Knowledge Classified
by Academic Discipline and Major Theme of the
Newspaper Articles

Science Discipline	Major Themes					
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medi-cine	Total
Anthropology			4			4
Astronomy	94		33			127
Biology	5		65	1	327	398
Chemistry	5		30	1	9	45
Computer Science		13	1			14
Engineering	1			1		2
Geology	8		17	2		27
Meteorology	1		6			7
Oceanography			1			1
Physics	70		69	29	10	178
TOTAL	184	13	226	34	346	803

From Table XIII, which is a summary of Table XII, it is noted that there are 803 items of knowledge in and of science, prerequisite to reading the 414 scientifically and/or technologically oriented articles.

1. Space

The 184 items of prerequisite knowledge for articles with the theme Space came mainly from the disciplines of astronomy and physics; 94 or 51.1 per cent from astronomy and 70 or 38 per cent from physics. There was only a scattering of items from the other disciplines.

2. Automation and Cybernetics

The articles with this theme have only 13 items of prerequisite knowledge and all came from Computer Science.

3. Science

The articles with the theme Science had 226 items of prerequisite knowledge from the disciplines of physics, biology, astronomy, chemistry, geology, meteorology, anthropology, oceanography, and computer science in that order of number of items. The greatest portion of the items came from physics, biology, astronomy and chemistry.

4. Nuclear Energy

The articles with the theme Nuclear Energy had 34 items of prerequisite knowledge, 29 of which came from physics.

5. Medicine

The greatest number of items of prerequisite knowledge pertained to the articles with the theme Medicine. The 156 medical articles required 346 or 43.1 per cent of the 803 items of prerequisite knowledge of which 327 were classified within the discipline biology. The 327 items prerequisite to the articles with the theme Medicine made up 84.7 per cent of the 398 items of biological knowledge found to be prerequisite to the articles read. Notice that only ten items were classified as physics and nine as chemistry.

6. Total

The total average demand in terms of prerequisite items of knowledge was about two items per article. The greatest demand was placed on knowledge from biology which here included 49.6 per cent of the items of prerequisite knowledge. The second position of importance was occupied by physics with 22.2 per cent of the total items of prerequisite knowledge. The academic area in third position of importance was astronomy which includes 15.8 per cent of the prerequisite items. The remainder of the disciplinary areas are the source of only 12.4 per cent of the items of prerequisite knowledges.

When the numbers of items of prerequisite knowledge classified according to article themes as in Table XIII are compared with the respective numbers of articles requiring prerequisite knowledge listed in Table XI it is noted that 131 articles classified as Medicine required 346 items or more than 2.6 items per article. The articles with the themes Space and Science each required an average of 2.4 items per article. Articles with the themes Automation-Cybernetics and Nuclear Energy averaged 2.2 and 2.1 items of prerequisite knowledge per article respectively.

Problem III - 1. Magazine Study

To determine the number of articles that were scientifically and/or technologically oriented.

Method of Analysis

The selected magazines were carefully read and all articles with a scientific or technological orientation were clipped and filed for further analysis.

Articles included in this phase of the study met the same criteria as established for the newspapers. See page 41 and 42.

Results

There were 92 articles with a scientific and/or technological orientation found in the sample of 48 magazine issues selected from the six month subscriptions to eight popular magazines.

It is noted from Table XIV that the number of scientifically and/or technologically oriented articles varied from 32 in Reader's Digest to two in National Geographic.

TABLE XIV

Number of Magazine Articles with a Scientific and/or Technological Orientation

I. General Interest Magazines	Number of Articles	
Life	3	
National Geographic	2	
Reader's Digest	32	
Redbook	7	
Saturday Evening Post	3	
Time	22	
Total		69
II. Women's Magazines		
Ladies Home Journal	5	
McCall's	18	
Total		23
Total for both groups		92

Problem III - 2. Magazine Study

To determine the nature of the themes of the scientifically and/or technologically oriented articles selected from the magazines.

Method of Analysis

The method of analysis employed was the same as that employed in the newspaper analysis. See page 42.

Results

The grouping of individual themes of the magazine articles resulted in the establishment of five major themes which best summarized the nature of the individual themes. These five major themes were:

1) Space
2) Automation - Cybernetics
3) Science
4) Nuclear Energy
5) Medicine

The articles classified within each major theme met the same criteria as those established for the newspaper articles. See page 43 and 44.

TABLE XV

Number of Scientifically and/or Technologically Oriented Magazine Articles Classified According to Major Theme

Magazines	Major Themes				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
General Editorial					
Life	1	0	0	0	2
National Geographic	2	0	0	0	0
Reader's Digest	4	0	9	1	14
Redbook	0	4	1	0	6
Saturday Evening Post	0	0	1	0	2
Time	3	0	9	1	9
Sub Total	10	4	20	2	33
Women's Magazines					
Ladies Home Journal	0	0	1	0	4
McCall's	0	0	2	0	16
Sub Total	0	0	3	0	20
TOTAL	10	4	23	2	53

Examination of Table XV reveals that 53 or 57.6 per cent of the 92 articles had the major theme Medicine, 23 or 21 per cent had the major theme Science, and that articles with these two themes account for 82.6 per cent of all the scientifically and/or technologically oriented articles in the eight magazines studied.

Of the three remaining themes Space accounts for ten or 10.9 per cent, Automation-Cybernetics accounts for four or 4.3 per cent and Nuclear Energy for two or 2.2 per cent.

The 23 articles selected from the Women's Magazine had either the theme Medicine or the theme Science. The 20 articles with the theme Medicine made up 87 per cent of the scientifically and/or technologically oriented articles found in Women's magazines and also 37.7 per cent of the 53 such articles found in the eight magazine samples.

Problem III - 3. Magazine Study

To determine the distribution of articles when a classification of science and/or technology is imposed.

Method of Analysis

The method of analysis was the same as that employed for the newspapers. See page 45 and 46.

TABLE XVI

Number of Magazine Articles Oriented Toward Science, Technology or Both, Classified According to Major Theme of the Article

Magazines	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
General Editorial Magazines					
Science	1	0	8	1	4
Technology	4	4	7	1	17
Both Science and Technology	5	0	5	0	12
Women's Magazines					
Science	0	0	2	0	1
Technology	0	0	1	0	16
Both Science and Technology	0	0	0	0	3
Total					
Science	1	0	10	1	5
Technology	4	4	8	1	33
Both Science and Technology	5	0	5	0	15

Results

Within the 92 magazine articles selected 50 or 54 per cent were found to be technologically oriented, 17 or 18 per cent oriented toward science, and 25 or 27 per cent included both science and technology. Referring to Table XVI it is noted that of the ten articles with the Space theme one was oriented toward science, four toward technology and five included reference to both science and technology. All four of the Automation-Cybernetics articles were oriented toward technology. The 23 articles with Science themes included ten oriented toward science, eight toward technology and five toward both science and technology. The two Nuclear Energy articles were equally distributed between science and technology; the 53 Medicine articles included five oriented toward science, 33 toward technology and 15 toward both science and technology.

When the Women's magazines alone are considered it is found that the three articles with the major theme Science included one article oriented toward technology and two oriented toward science. Within the 20 articles with the theme Medicine one is science oriented, 16 are oriented technologically and three are both.

Problem III - 4. Magazine Study

To determine the number of articles that involve science and/or technology that have one or more social implications.

Method of Analysis

The criteria established were the same as for newspaper articles. See page 48.

Results

It was found that 40 or 44.5 per cent of the magazine articles that contained reference to or discussion of science and/or technology also involved some social implication. Examination of Table XVII reveals that five or 12 per cent of the science oriented articles included social implications, 24 or 59 per cent of the technologically oriented articles included such implications as did 12 or 29 per cent of the articles classified as both.

TABLE XVII

Number of Magazine Articles Including Some Social Implication, Classified Accoring to Major Themes and Science and/or Technology

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medi-cine	Total
Science	0	0	1	0	4	5
Technology	1	4	4	1	14	24
Both Science and Technology	2	0	4	0	6	12
TOTAL	3	4	9	1	24	41

When the data in Table XVII are considered with those in Table XVI it is noted that only three of the ten articles with the theme Space included some social implication and that these three were classified either as technology or both; the four articles with the theme Automation - Cybernetics included social implications; one of the ten Science theme articles classified as science, four of the eight Science theme articles classified as technology, and four of the five Science theme articles classified as both included social implications; of the two articles with the theme Nuclear Energy only the one classified as technology contained a social implication; four of the five Medicine theme articles classified science, 24 of the 33 Medicine theme articles classified technology, and 12 of the 15 Medicine theme articles classified both contained social implications.

In summary, social implications were found in 30 per cent of the Space oriented articles, 100 per cent of the four Automation-Cybernetics articles, 39 per cent of the Science articles

50 per cent of the Nuclear Energy articles and 45 per cent of the articles classified Medicine.

Problem III - 5. Magazine Study

To determine the nature of the social implications included in articles which involve science and/or technology.

Method of Analysis

The method of analysis was the same as that followed for the newspapers. See page 50.

Results

1. There were 84 statements prepared that identified the nature of social concerns either implied or directly stated in the 41 articles containing social implications.

2. The 84 statements included social interrelationships between society and science and/or technology, political decisions or issues that involved science and/or technology, and economic relationships that involved science and/or technology. The 84 statements were thus classified as either social, political, or economic.

A statement of concern was considered to be social when the discussion involved the direct effect or involvement of science and/or technology upon individuals or groups in a society. Some items were health, leisure, safety, and employment.

A statement of concern was classified as political if it involved a voting judgment, right or responsibility of the citizen or his duly elected or appointed representative concerning a scientific or technological problem.

A statement of concern was classified as economic when it was related to a financial cost or gain and also involved a scientific or technological problem.

TABLE XVIII

Number of Statements Indicating Social Implications Classified According to Concern, Major Theme of the Magazine Article, Science, Technology or Both.

	Space			Automation-Cybernetics			Science			Nuclear Energy			Medicine			Total		
	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic	Social	Political	Economic
Science	0	0	0	0	0	0	1	0	0	0	0	0	5	3	2	6	3	2
Technology	2	5	1	8	4	6	1	3	2	1	0	0	12	3	5	24	15	14
Both Science and Technology	1	3	1	0	0	0	3	0	4	0	0	0	6	1	1	10	4	6
Total	3	8	2	8	4	6	5	3	6	1	0	0	23	7	8	40	22	22

3. Referring to Table XVIII it is noted that when the 84 statements indicating social implications were classified 40 or 47.6 per cent were social concerns, 22 or 26.2 per cent were political concerns, and 22 or 26.2 per cent were economic concerns.

4. Articles classified as technology were the source of 53 or 63 per cent of the statements of social implications. These statements included 24 of social concern with the remainder about equally distributed between the groupings of economic and political concern.

5. When the number of social implications is examined within the major theme classifications it is noted that Medicine accounts

for 38 or 45 per cent of the total with the remainder being about equally distributed among Space, Automation-Cybernetics and Science.

6. Comparison of the proportional distribution of the number of items of social, political, and economic concerns within and among the major themes classifications tabulated in Table XVIII shows that Space articles included more political concerns than any other of the major themes; Medicine articles included more social and economic concerns. When the data in Table XVIII are compared with the data in Table XVII it is noted that Space articles include almost three items of political concern per article and this is almost three times more than is found in any of the other major themes.

When the number of items of social concerns per article is examined it is found that articles with the theme Medicine are the source of one item per article, Automation-Cybernetics two per article, Space and Nuclear Energy each one per article and Science one for every two articles.

7. The items of social concern included automation and employment changes; the increasing demand for technically trained employees; sociological and psychological effects of changing working conditions; social effects of new chemical and biological agents; scientific and technological developments in crime detecting, in medicine and health, and in weather; and the population explosion.

The items of social concern and their frequencies of appearance are found in Table XIX.

TABLE XIX

Topics of Social Concern in Magazine Articles Classified According to Major Themes

Topic	Frequency
SPACE-SOCIAL	
1. Trips to mars at a projected cost of $30,000 per passenger may become reality in the future.	1
2. The supersonic transport will create a sonic boom problem for which public tolerance is not yet known.	1
3. The supersonic transport will provide faster and cheaper transportation.	1
AUTOMATION-CYBERNETICS-SOCIAL	
1. Research and its technological offspring need an ever growing army of technically trained men and women.	3
2. Manual work is swiftly disappearing and this decrease has already stranded some four million Americans and plunged us into an employment dilemma.	1
3. A minimum of a high school education will be required for 94 per cent of the jobs of tomorrow.	1
4. Automation in the food services has enabled all stores, even in remote districts, to offer a wide variety of fresh foods and produce to the public.	1
5. New studies indicate that workers in factories and offices with high noise levels carry a burden of resentment and irritation which may lead to more "social conflicts" at home and on the job.	2
SCIENCE-SOCIAL	
1. Science can contribute to the alleviation of human misery by finding a method of controlling the growth of the water hyacinth which serves as an ideal incubator for mosquitoes and which kills wildlife by upsetting the normal environment.	1
2. The development of a tornado warning system would greatly reduce the toll of deaths and injuries caused by such storms.	1

TABLE XIX (continued)

Topic	Frequency
3. An effective poison against rats would help to relieve the human misery caused by diseases transmitted by rats.	1
4. Germ and chemical warfare can make war more humane and even "benign".	1
5. A British physicist warns that eventually we will have to limit the earth's population to avoid reaching the limit to which heat can be tolerated in a life supporting environment.	1
NUCLEAR ENERGY-SOCIAL	
1. The possibilities for the application of neutron-activation analysis techniques in the field of crime detection and drug purity control are almost endless.	1
MEDICINE-SOCIAL	
1. Drug addiction has been recently accepted as an illness and doctors feel it can be understood and treated as such.	1
2. Science is making such continuous, often dramatic, progress in understanding and treating sterility that the word "hopeless" can be all but forgotten when talking about barren marriages.	3
3. Research in the medical sciences and in engineering has come up with such excellent new apparatus, as well as new drugs, that the comfort and welfare of the sick have been immeasurably improved.	6
4. Today's new methods of diagnoses and treatment have greatly decreased both the incidence of disabling illnesses and the death rates within our population.	5
5. The possibility is open that man may one day control heredity and direct the future evolution of the race.	1
6. An influential theologian stated - contraceptive pills are "not inherently evil."	1

TABLE XIX (continued)

	Topic	Frequency
7.	The competitive pressures of society that make it difficult for a patient to heed his doctors advice of "moderation" are becoming a problem of concern.	1
8.	Birth control promises to help the poor rise up from grinding poverty and despair.	1
9.	Emergency medical care in the United States today is almost everywhere an unorganized crazy quilt of miscellaneous bits and pieces that just don't fit together.	1
10.	America's infant mortality rate is unnecessarily high. Careless physician's and overcrowded understaffed hospitals are part of the problem.	1
11.	Medical research in mental retardation is far ahead of medical practice and public acceptance.	1
12.	It has not yet been proven that cholesterol is a chief culprit in heart disease and the public should not be "panicked" into unproven special diets.	1

8. The concerns of the political topics generally involved the Federal Government and included federal support of scientific research and development; the need for public understanding and approval of major federal programs such as NASA; federal regulation of the drug and communication industries; federal programs dealing with education, medicine, and population control; and problems of old age.

The nature of the political topics contained in articles in each of the major themes is noted in Table XX.

TABLE XX

Topics of Political Concern in Magazine Articles
Classified According to Major Themes

Topic	Frequency
SPACE-POLITICAL	
1. Many countries including Russia praised the United States for the successful Ranger flight.	1
2. The development of a competitive supersonic transport would gain enormous political prestige for the United States.	1
3. NASA has indicated space flight failures by letters and successful flights by numbers.	1
4. The great outcry over the first Ranger failures prompted the House subcommittee to call for tighter NASA control over the Jet Propulsion Laboratory.	1
5. Congress will have to decide whether development of the supersonic transport will be federally supported since the development will involve "huge" amounts of taxpayer's money.	2
6. The supersonic transport project is so large that it will require federal support and direction.	1
7. Private airplane industries in the past have received considerable financial support from the government for military projects and cannot finance, alone, a commercial project as large as the development of the supersonic transport.	1
AUTOMATION-CYBERNETICS-POLITICAL	
1. Both government and management must solve the problem of "structural" unemployment caused by mechanization and automation.	1
2. The 1964 Congress has voted more money for education and retraining than any other congress in history.	1
3. Government and industry invest great sums of money in research which creates more change and more jobs.	1

TABLE XX (continued)

Topic	Frequency
4. The Federal Communications Commission has asked all T.V. and radio stations to review their practices of using reverberation and emphasis on treble to heighten the noisy affects of commercials.	1
SCIENCE-POLITICAL	
1. Emotional opposition to the use of germ and chemical warfare has prevented our government from exploiting the enormous offensive opportunities of this type of warfare.	1
2. The Federal Aviation Agency is conducting tests on sonic boom with the hope of having firm and convincing arguments against the ever increasing complaints of private citizens.	1
3. Newer methods of warfare can be developed only with mammoth federal expenditures of money for scientific research and development.	1
NUCLEAR-POLITICAL	
None	
MEDICINE-POLITICAL	
1. Doctors are urging that drug addicts need medical care, not jail sentences.	1
2. The lengthened life span and its effect upon the number of citizens reaching old age has forced the government to consider offering financial support or nursing facilities to senior citizens.	2
3. Every city and county needs at least one good hospital emergency department, an organized system of emergency care, and the benefits of a statewide ambulance licensing law covering both ambulance equipment and the training of ambulance crews.	1
4. Police agencies, especially the Federal Bureau of Narcotics, have threatened and intimidated doctors preventing them from supporting clinical research with drug addicts.	1
5. The Pure Food and Drug Act has restrained doctors from conducting research into drug addiction.	1

TABLE XX (continued)

Topic	Frequency
6. Possible future governmental regulation of patent rights threatens to deter drug companies from performing adequate research work.	1

9. Topics of economic concern such as the high cost of research and development, the economic importance of retraining workers as new jobs appear, the relationship of profit to research, the savings that citizens derive from new scientific and technological developments, and the cost of and savings from new developments are listed in Table XXI.

TABLE XXI

Topics of Economic Concern in Magazine Articles
Classified According to Major Themes

Topic	Frequency
SPACE-ECONOMIC	
1. The United States must build a competitive supersonic transport or lose the world market in transport airplanes.	1
2. The six Ranger failures cost 260 million dollars; an amount that no private industry could absorb.	1
AUTOMATION-CYBERNETICS-ECONOMIC	
1. Labor unions, research laboratories, and industries are setting aside money for the advanced training of personnel.	1
2. Technological developments of new energy sources are partly to blame for the losses incurred by the coal industry after the second World War.	1
3. To meet competition the coal industry is mechanizing and automating.	1
4. More man-hours of production plus breakthroughs in science and technology have more than quadrupled our productive output within a half-century.	1

TABLE XXI (continued)

Topic	Frequency
5. Money spent on research and development has multiplied 35-fold since 1941.	1
6. Manufacturers are spending millions of dollars searching out means of reducing noise levels in work areas.	1
SCIENCE-ECONOMIC	
1. The development of a deep sea research craft may hold interesting possibilities for ship salvaging operations and deep sea oil drilling and mining operations.	1
2. Scientists are engaged in finding economical ways of eliminating or controlling the destructive growth of the hyacinth, a water plant, that was introduced to this country from a foreign area.	1
3. Scientists are working to develop an advance tornado warning system that will enable communities to prepare for the storm and reduce damage caused by it.	1
4. The risk in transporting food stuffs over long distances has been decreased through the use of nitrogen refrigerants.	1
5. The development of a new rat poison promises to provide an inexpensive answer to the economic burden of crop losses due to rat infestation.	1
6. The price tag for the completed Verrazano-Narrows bridge is a staggering 325 million dollars.	1
NUCLEAR-ECONOMIC	
None	
MEDICINE-ECONOMIC	
1. If proper medical treatment were made available to drug addicts hundreds of millions of dollars wasted in crime and smuggling could be saved each year.	1
2. Early detection and prevention of crippling strokes could reduce the number of families that are heavily dependent on the state.	1

TABLE XXI (continued)

	Topic	Frequency
3.	The best of medical care is now available for a great majority of the people regardless of their economic situation.	2
4.	A proper oral contraceptive program could save taxpayers hundreds of thousands of dollars by reducing the burden of welfare programs.	1
5.	Whenever improvement in medical facilities is suggested the shortage of money as well as manpower is confronted.	1
6.	The research costs of experimenting with and testing new drugs are high.	1
7.	Early reports of a possible link between cholesterol and heart disease spurred the marketing of many special food products by enterprising businessmen.	1

Problem III - 6. Magazine Study

To determine the knowledge in and of science prerequisite to the reading of the selected articles.

Method of Analysis

The method of analysis was the same as that employed for the newspapers. See pages 61 and 62.

Results

TABLE XXII

Number of Articles in Magazines with Knowledge in and of Science Prerequisites

	Major Themes					
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Number of articles requiring prerequisite knowledge	6	1	15	2	34	58

Comparing the data from Table XXII with those from Table XV it is noted that 58 or 63 per cent of the 92 articles had some prerequisite knowledge. This includes six of ten or 60 per cent of the Space articles; one of four or 25 per cent of the Automation-Cybernetics articles, 15 of 23 or 65 per cent of the Science articles, all of the Nuclear Energy articles and 34 of 53 or 64 per cent of the articles with the theme Medicine.

TABLE XXIII

Items in and of Science, Prerequisite to the Reading of the Selected Magazine Articles and Their Frequency of Appearance Classified According to the Major Theme of the Article and Academic Discipline

Prerequisite Knowledge[1]	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
I. ANTHROPOLOGY - none					
II. ASTRONOMY					
1. A galaxy is a major system consisting of stars, nebulae planets, and interstellar dust.			1		
2. The orbits of planets and the trajectories of space craft are not erratic but can normally be predicted through known laws of mechanics.	1				
3. The earth's atmosphere or surrounding envelope of air interferes with telescopic viewing of objects in space by refracting and/or reflecting light waves.	1				
4. The universe is the totality of the observed and postulated celestial world, e.g., planets, stars, interstellar dust, etc.			1		
Sub Total	2		2		
III. BIOLOGY					
A. Morphology and Anatomy					
1. An artery is a vessel carrying blood from the heart to other parts of the body.					2

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[1] Definition or explanation limited to that specifically required in context of the article or articles.

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
2. The cervical canal is a part of the female genital tract that leads to the area where fertilization of the egg takes place.			1		
3. The cornea is the transparent outer covering of the eye located in front of the pupil or iris.					1
4. Fallopian tubes are ducts through which ripe ova pass to the uterus.			1		
5. Hair follicles are the hair growth cells.					1
6. The larynx is the voice box.					1
7. Lymph nodes are packets of tissue which filter the liquid part of the blood.					1
8. Bone marrow is the soft tissue in the central cavity of a bone; it may produce red blood cells.					1
9. The ovaries are the egg producing organs of the female.			1		2
10. The pelvic opening is a basin-like cavity formed by the pelvic bone structure.					1
11. The placenta is the spongy tissue that forms on the wall of the uterus and functions as a terminal for the exchange of materials between mother and fetus.					1
12. The prostate gland is a male gland surrounding the first part of the urethra.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
13. The retina is the layer of tissue inside the eyeball that contains the light sensitive organelles of the eye.					1
14. Nasal sinuses are natural cavities found in the skull structure.					1
15. Tracheal and bronchial tubes are the passageways through which air travels from the mouth or nose into the lungs.					1
16. The umbilical cord is the life line that joins the placenta to the baby and through which blood, nutrients, oxygen, and waste products flow.					1
17. The uterus is the organ of female mammals in which the ovum is deposited and in which the embryo and fetus are developed and protected.			1		2
18. The womb is a common name for the uterus.			1		
Sub Total			5		18
B. Physiology					
1. Amino acids are chemical substances from which the body develops materials needed for proper growth and development.					1
2. Anovulant steroids are hormones that affect ovulation.					1
3. Antibodies are chemical substances produced by the body to fight infection.			1		3

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
4. The autonomic nervous system controls certain body functions and reactions automatically without the person being aware of the activities.					2
5. Basal body temperature refers to the basic or fundamental temperature of the body.			1		
6. The term biochemical refers to the chemical processes that take place within a living organism.			2		
7. Cholesterol is a fatty substance often deposited in blood vessels.					1
8. Certain chemicals found in the blood stimulate the blood to coagulate at wounds. In the absence of these chemicals the blood will not clot.					1
9. Cortisone is an adrenal-gland hormone.					1
10. Hormones are chemicals produced by the body and regulate body functions.					5
11. A life support system consists of devices which simulate the environment of earth, maintains proper temperature and pressure, supplies the correct proportion of oxygen, and effectively disposes of waste material.	1				
12. Menopause is the period in a woman's life when her reproductive organs cease to produce eggs, and menstraution stops.					2
13. Menstruation is the discharge at more or less regular intervals of a bloody fluid from the vagina.					4

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
14. Metabolism is the process through which the body uses food for energy and growth.					5
15. Neural activity refers to the action within or between nerve cells.					1
16. The nutritional value of various foods refers to the amount of chemical substances and vitamins that food supplies to the person eating the food.					1
17. Ovulation is the release from the ovary of a mature egg ready to be fertilized.					2
18. Photosynthetic plankton are algae that can provide more food per volume than other forms of higher life.			1		
19. Progesterone is a female hormone.			1		
20. Proteins and carbohydrates are chemical materials present in foods necessary for proper body functioning.					2
21. Protoplasm is the term applied to the living part of a cell.			1		
22. The functions of the body are regulated by a delicately balanced production of chemicals which affect the processes that occur within each cell.			1		
23. Respiration is a term given to the breathing process.					1
24. The thyroid gland regulates body metabolism.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
25. The chemical structure and composition of viruses is similar to the chemical structure and composition of that part of a cell that regulates the functioning of the cell.			1		
Sub Total	1		10		34
C. Disease and Disorders					
1. Adrenal failure refers to the adrenal glands failure to produce a chemical hormone.					1
2. Anemia is a condition in which the blood does not contain sufficient red blood cells.					2
3. Rheumatoid arthritis is an inflammation of the joints.					2
4. During long periods of inactivity muscles and tendons often atrophy, shorten in length, decrease in diameter, and otherwise weaken.					3
5. Benign refers to a growth that is not malignant (cancerous).					2
6. Carcinogenic means cancer inducing.					1
7. Cerebral palsy is a form of nerve paralysis or degeneration.					1
8. Cleft lip and palate is a condition of abnormal development in which the roof of the mouth and/or upper lip do not fuse together properly.					1
9. Congenital defects are hereditary body structure defects.					2

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
10. Convulsions are sporadic, uncontrollable contractions of muscle.					2
11. Coronary thrombosis refers to the closure of a coronary (heart) artery.					1
12. Cyanatic--blue appearance of skin is usually due to insufficient oxygen in the blood.					1
13. Ovarian cysts are hard fibrous masses of tissue formed in the ovary.					2
14. Diabetes refers to the illness in which the patient does not produce adequate amounts of insulin.					1
15. Disorientation in space consists of a lack of reference points manifesting itself in the absence of the feeling of weight, movement and direction.	1				
16. Gangrene refers to the death of body tissue usually caused by interference with the local nutrition.					2
17. Gastrointestinal discomfort can be caused by excessive gas in the stomach and intestines.					1
18. A hemorrhage refers to any discharge of blood from a blood vessel.					2
19. Hormonal inbalance refers to the imbalance of regulatory body chemicals.					2
20. Hypertension is high blood pressure.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
21. Incubation period refers to the time during which a virus is passive and prior to its period of activity in which it produces the disease causing toxins (chemicals).					1
22. Puerperal infection refers to infection occurring during childbirth.					1
23. A yeast infection refers to the inflammation caused by the entry of yeast cells (plants) into the body--usually through an open wound.					1
24. Insomnia is the inability to sleep.					1
25. Jaundice is a yellow discoloration of the skin and eyes due to the lack of normal liver bile flow.					1
26. A malignancy is a cancerous growth.					1
27. Masochism refers to the tendency to enjoy pain.					1
28. Meningitis is an inflammation of the membranes covering the brain and spinal cord.					1
29. Neurological disorders are disorders of the nervous system.					2
30. Neuroses are emotional disturbances.					1
31. Obesity is the condition of being over weight.					1
32. Osteomyelitis is an infection of a bone.					1
33. Parasites are organisms that live on or within a host organism.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
34. Pneumonia is a respiratory disease that causes fluids to seep into the lungs thus making breathing difficult.					2
35. Psoriasis is a noncontagious chronic skin disease.					1
36. Psychosis is an extreme mental disorder.					1
37. Psychosomatic disorders are disturbances of the mind manifested in the body.					2
38. Pulmonary edema refers to seepage of fluid into the lungs.					1
39. Respiratory illnesses affect the lungs and/or breathing tubes.					1
40. Chemical incompatability between a baby's blood and the mother's blood may be due to a hereditary RH factor.					1
41. Rheumatic heart disease refers to inflammation of the heart muscle and distortion of the valves of the heart.					1
42. Some people are more susceptible to diseases because of their body make-up. They may have weaker systems of anti-body production, lower white blood-cell counts, and/or a defective lymph system.			1		
43. Syphilis is a communicable venereal disease.					1
44. Thrombophlebitis is the inflammation of a vein associated with an blood clot within the vein.					1
45. Thyroid disorders frequently affect the person's ability to use the energy in food for activity or growth.					1

TABLE XXIII (Continued)

Prerequisite Knowledge			Major Theme		
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
46. Toxemia is a condition characterized by poisonous products in the blood with a resultant illness of the patient.					2
47. Disease organisms can be transmitted from one organism to another, through blood, saliva, and excretory wastes.			1		
48. Perforating ulcers are sores on the walls of the digestive tract that have perforated the wall upon which they are located.					2
Sub Total	1		2		61
D. Diagnosis and Treatment					
1. Antibiotics are drugs used to fight bacterial infection.					1
2. An anticoagulant chemical interfers with the ability of the blood to clot at the area surrounding a wound.			1		
3. An anesthetic is a chemical that is used to reduce or remove the sensation of pain.					3
4. Artificial insemination refers to the process of artificially introducing sperm into a female.					1
5. An autopsy is an examination of the body after death.					1
6. Substances in the blood can be analyzed to indicate the presence of certain diseases in parts of the body.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Space	Major Theme Automation-Cybernetics	Science	Nuclear Energy	Medicine
7. A caesarean operation is the removal of the unborn child through an incision made in the mother's womb.					1
8. Chemical castration refers to the effect of a chemical that produces sterility of the male reproductive glands.					1
9. Digitalis is a drug used to stimulate a failing heart.					1
10. An electrocardiogram is a graph of the heart's action and is used in the diagnosis of heart disease.					1
11. Deep freezing can temporarily slow or even stop the normal changes that continuously take place in living organisms.			1		
12. In many cases of grafting donor skin, the body builds up a chemical rejection of the graft.					1
13. Human tissue cultures are small amounts of human body tissue that are kept alive in an artificial medium.					
14. Prolonged use of antibiotics may lead to eventual immunity against the antibiotic.			1		1
15. Intravenous feeding consists of injecting food in solution into a vein.					1
16. Metabolism rates are commonly measured by testing for the rate at which the body uses oxygen.					1
17. A neurological examination is an examination of the nervous system.					1

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
18. A pathologist is a scientist who specializes in the detection of disease through the examination of diseased tissues.					1
19. A prosthesis is an artificial replacement of a part of the body.					1
20. Psychotherapy is a form of treatment for mental disturbances.					1
21. The presence of antibodies in the body can create resistance to certain diseases.			1		
22. A sedative is a drug that is used to calm the nerves and decrease excitement.					1
23. Shock manifests itself by a drop in blood pressure, rapid and weak pulse, pale, moist, clammy skin, marked thirst, and a state of great anxiety.					2
24. Sterile needles are free of disease causing bacteria, viruses, and other pathogens.					1
25. Suppositories are forms of medication prepared for insertion into the rectum.					1
26. A vaccination is an injection of dead or weakened bacteria and/or viruses that stimulate the body's production of antibodies.					
Sub Total			6		25

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	 Automation-Cybernetics	 Science	 Nuclear Energy	 Medicine
E. Genetics					
1. Genetic or hereditary factors refer to the transmission of body characteristics from parents to offspring.					2
2. Genetic material is that part of the material included in protoplasm that regulates the processes that go on within the cell.			1		
3. Genetic susceptibility or resistence refers to the body's hereditary tendency toward illness.					1
4. Heredity is a term given to the incompletely understood process by which the characteristics of an organism are determined and transmitted from one generation to the next.			1		
5. Inbreeding refers to successive breeding between members of the same family or generation.					1
6. The sexual reproduction of species has the possible advantage of more rapidly improving the species through the exchange of genetic material.			1		
7. The sperm contains chemicals (genetic material) that influence the development of hereditary characteristics.			1		
Sub Total			4		4
F. Taxonomy					
1. Bacteria are very small one-celled plants--some of which cause disease.					2

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
2. Spirochetes are a type of bacteria.					1
Sub Total					3
G. Ecology none					
H. Developmental Biology					
1. Living cells produce new cells by dividing.			1		
2. Egg cells are cells which have the potential, when fertilized, to develop into complete organisms.			1		
3. The terms embryo and fetus apply to the developing baby during progressive phases of its growth.			1		2
4. Gestation is a term which means pregnancy.					1
5. Growth phase refers to the observable differences of activity during the growth of an organism or part of an organism.			1		
6. An incubator here, refers to an environment that is conducive to the development of life.			1		
7. A ripe ovum is an egg cell that is matured and ready for fertilization.			1		2
8. During the earliest phases of development the fetus does not possess definite sex characteristics.			1		
9. Spermatozoa are the male fertilizing cells.					2
Sub Total			7		7

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
I. Miscellaneous					
1. A calorie is a unit of energy used in measuring the amount of available heat energy contained in foods.					2
Sub Total					2
IV. CHEMISTRY					
1. Acidity or alkalinity refers to the presence of acids or bases in the chemical make-up of a substance.			1		
2. Alloys are mixtures of metal substances the properties of which are different than any or all of the properties of the constituent substances used.	1				
3. A catalyst is a chemical substance that promotes or retards some chemical reaction.					1
4. Chlorine is a gaseous element which, when in aqueous solution, serves as an effective germ killer.					1
5. Distillation is the process of boiling a liquid, trapping the resulting gas, and condensing the gas back to a liquid. Mixtures of liquids can be separated because different liquids boil (change to gas) at different temperatures.			1		
6. Elements are pure forms of materials that cannot be further subdivided into simpler substances by ordinary chemical methods.	1				
7. Glucose is a type of sugar.					1
8. Inert materials are considered to be chemically inactive.					2

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. Oxygen is soluble in water.			1		
10. A saline solution is a mixture of salt and water.					1
Sub Total	2		3		6
V. COMPUTER SCIENCE					
1. Computer programming consists of designing or setting up the electronic circuits of a computer and determining their order of operation to enable the computer to automatically perform various mathematical operations.		1			
Sub Total		1			
VI. ENGINEERING					
1. Simulated ranger shots can be performed (without actually firing the rocket) by feeding predetermined information of the pseudo flight into control and computer devices.	1				
Sub Total	1				
VII. GEOLOGY					
1. Geological composition of ocean floors refers to the type and arrangement of materials that form the ocean floors.			1		
Sub Total			1		
VIII. METEOROLOGY - None					

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
IX. OCEANOGRAPHY					
1. Decompression is the process of slowly lowering the air pressure within the body of a deep sea diver from the increased underwater breathing pressure to normal atmospheric pressure.			1		
Sub Total			1		
X. PHYSICS					
A. Electricity					
1. An electric current can be induced in a coil of wire by a moving magnetic field surrounding or near the coil.					1
2. Frequency refers to a number of cycles or complete vibrations per second.			1		
3. Hydroelectricity refers to electricity produced through using the power of falling or rapidly flowing water.			1		
4. The major difference between light and radio waves is the length of the wave. Light waves are much shorter than radio waves.			1		
5. A megacycle is a million cycles.			1		
6. Microwaves refer to that part of the electromagnetic spectrum between radio waves and visible light waves.			1		

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
7. Short wave radiation refers to that part of the electromagnetic spectrum of high frequency and short wave length.			1		
8. Turbines are highly refined water wheels.			1		
Sub Total			7		1
B. Mechanics					
1. Buoyancy is the upward force exerted on a body immersed or floating in a fluid.			1		
2. Centripetal force causes an object to travel in a circular path.	1				
3. Atmospheric drag, which decreases the motion of objects in the air, does not exist in space.	1				
4. Solids expand and/or contract (take up more or less space with the same amount of mass) with changes in temperature.			1		
5. Stick and rudder controls affect the flight of an airplane through changes in the velocity and therefore the pressure and thus, are useless in space or wherever the air pressure is low.	1				
6. A constant force produces constant acceleration.	1				
7. A gravitational field is an area surrounding an object in which that objects mass attracts or exerts a force upon the mass of other objects within the field.	1				

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
8. Inertia is that property of matter which determines its tendency to maintain its present state of motion.	1				
9. Fluids may pass through membranes because of different pressures on either side of the membrane. Molecules of the fluid are forced through tiny openings in the membrane by the unbalanced pressures.			1		
10. Momentum, the product of a moving object's mass and velocity, is always conserved.	1				
11. Distances can be precisely determined through the use of radar by measuring the time between the sending of a radar beam and the receiving of the reflected beam. The speed of a radar beam is known and the time interval can be related to the distance the beam traveled.	1				
12. For every action there is an opposite, equal reaction. Thus a gas spurting out of steering jets will exert an equal and opposite force on the space craft and cause it to move away from the direction of the gas flow.	2				
13. Sonar refers to sound waves which are emitted underwater. The sound waves bounce off underwater objects and can be used somewhat like radar in determining the depth and surface structure of sea beds or ocean floors.			1		
14. The trajectory of a space craft is the path which it follows.	1				
Sub Total	11		4		

TABLE XXIII (Continued)

Prerequisite Knowledge	Major Theme				
	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
C. Nuclear and Atomic Energy					
1. A dosimeter is a device used to measure the amount of radiation received from a radio-active source.				1	
2. Energy can be transformed into matter.			1		
3. Gamma rays exhibit a wave form and a specific wave length.				1	
4. An isotope is a form of an element which differs in atomic weight from other forms of the same element.					1
5. Neutron bombardment consists of bombarding a material with neutrons emitted from a radio-active source. Some of the neutrons pass through the material, others are trapped and added to the nucleus of an atom or otherwise react with the atom to make it radioactive.				1	
6. Radiation effects include changes in the structure of materials and the liberation of heat. It can effect electronic circuits and damage space craft instruments.	2				
7. Radioactive materials emit particles and/or rays.				1	
8. A nuclear reactor is a device which uses radio-active fuel and produces energy through nuclear reactions.				1	

TABLE XXIII (Continued)

Prerequisite Knowlege	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine
9. Solar winds consist of electromagnetic radiations and charged particles which can strike a space craft and gradually push it off its normal path.	2				
Sub Total	4		1	5	1

Table XXIII includes a listing of the individual science concepts and principles that are prerequisite to reading the articles. The concepts are classified according to traditional science disciplines.

A summary of these data appears in Table XXIV where the frequency of occurrence of a given concept is classified according to major theme and according to the traditional disciplines of science and technology:

1) Anthropology
2) Astronomy
3) Biology
4) Chemistry
5) Computer Science
6) Engineering
7) Geology
8) Meteorology
9) Oceanography
10) Physics

TABLE XXIV

Number of Items of Prerequisite Knowledge Classified by Academic Discipline and by Major Theme of the Magazine Article

	Space	Automation-Cybernetics	Science	Nuclear Energy	Medicine	Total
Anthropology						0
Astronomy	2		2			4
Biology	2		34		154	190
Chemistry	2		3		6	11
Computer Science		1				1
Engineering	1					1
Geology			1			1
Meteorology						0
Oceanography			1			1
Physics	15		12	5	2	34
TOTALS	22	1	53	5	162	243

There are 243 (Table XXIV) items of knowledge in and of science prerequisite to reading the 92 scientifically and/or technologically oriented articles found in a sample of popular magazines.

Space

The items of prerequisite knowledge for the ten articles with the theme Space came mainly from physics (15 of 22 items) with the remaining isolated items from astronomy, biology, chemistry, and engineering.

Automation-Cybernetics

The four articles with this theme had only one item of prerequisite knowledge and this came from the computer sciences.

Science

The 23 articles with the theme Science required 53 items of prerequisite knowledge from the disciplines of biology, physics, chemistry, astronomy, geology, and oceanography in that order; the greatest number came from biology (34 of 53) followed by physics (12 of 53).

Nuclear Energy

The two articles within the theme Nuclear Energy had five items of prerequisite knowledge all of which came from physics.

Medicine

The 53 articles with the theme Medicine had 162 items of prerequisite knowledge, 154 of which were from the discipline biology. Although the Medical articles make up 58.7 per cent of the total number of articles they required 66.7 per cent of the items of prerequisite knowledge and 81 per cent of the items of prerequisite knowledge were from the biological disciplines. There were only six chemistry and two physics items of prerequisite knowledge found here.

Total

The average demand in terms of items of prerequisite knowledge per article is 2.6. The greatest demand is placed on biological knowledge which makes up 78.2 per cent of the items followed by physics which makes up 14 per cent of the total. The number of items of prerequisite knowledge per article ranges from 3.1 for Medicine to 2.5 for Nuclear Energy to 2.3 for Science to 2.2 for Space to .25 for Automation - Cybernetics

Summary - Problem III, Newspaper and Magazine Study

The sample of 157 daily and 57 Sunday issues of 22 capitol city newspapers included a total of 414 scientifically and/or technologically oriented articles. The sample of six monthly issues of eight national magazines yielded 92 scientifically and/or technologically oriented articles. Within the limits of variability reported in these studies it can be concluded that both the newspapers and magazines carried approximately 2 articles per issue which were oriented toward science and/or technology.

In examining the major themes of the articles it was found that the major portion were concerned with Medicine. For the newspapers, 38 per cent of all the articles were classified Medicine while 57.6 per cent of the magazine articles were so classified. In both studies the major theme Science was second in frequency of appearance accounting for 33 per cent of the newspaper articles and 21 per cent of the magazine articles. The percentage of Space oriented articles appearing in the newspapers accounted for 22.5 per cent of the total which is more than twice the percentage of the Space oriented magazine articles.

It is obvious that of all the areas of science and technology, medically oriented subjects receive the greatest coverage. Such topics account for more than one-half of the magazine articles and almost two-fifths of the newspaper articles.

When the classification science, technology or both was imposed upon the newspaper articles it was found that 76 per cent were classified technology, 17 per cent science, and eight per cent both science and technology. Articles concerned with science exclusive of technology were found only within the major theme Science where one-half were oriented toward science alone.

A similar but less pronounced emphasis on technology also existed in the magazine articles where more than one-half of the articles were based on technology, 27 per cent combined science and technology, and 18 per cent were devoted to science.

Clearly, the major emphasis in scientific and/or technologically oriented articles in newspapers and magazines is on technology and technological applications or implications of science. Less than one-fifth of the newspaper and magazine articles discussed science as an activity separate from technology.

Of the 414 newspaper articles included in this study, 100 or less than one-fourth contained social implications of science or technology for citizens or their elected officials. The proportion of articles containing social implications remained about one out of four in the daily as well as the Sunday editions. Social implications were more frequent in the magazine articles occuring in 44 of the 92 articles.

When the nature of the social implications in the newspapers was described by one or more statements and these statements were classified as science, technology, or both, it was found that the Social implications of science were infrequently discussed, whereas the social implications of technology were frequently discussed and accounted for more than 86 per cent of the statements.

When the nature of the social implications contained in the magazine articles was examined it was found that more than one-half of the descriptive statements were related to social implications of technology, and only about ~~20~~ 13 per cent emphasized the social implication of science.

A comparison of the proportional distribution of the number of items of social, political and economic concern within and among the major theme classifications revealed that political concerns were emphasized in Space articles, social concerns in the articles classified Medicine and economic concerns in the articles classified Science.

Knowledge in and of science prerequisite to reading the articles averaged about 2 items per article for the newspapers and 2.6 items per article for the magazines. The greatest demand for prerequisite knowledge occurred in articles classified Medicine and the greatest proportion of items of prerequisite knowledge were from the biological sciences. In terms of numbers of items of prerequisite knowledge the disciplines of physics and astronomy ranked second and third respectively.

APPENDIX A

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APPENDIX B

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APPENDIX C

Listing of Newspapers

Arkansas Gazette (Little Rock, Arkansas)

Sacramento Bee (Sacramento, California)

Denver Post (Denver, Colorado)

Honolulu Star Bulletin (Honolulu, Hawaii)

Indianapolis Star (Indianapolis, Indiana)

State Journal (Frankfort, Kentucky)

Evening Capital (Annapolis, Maryland)

Record American (Boston, Massachusetts)

Jefferson City Post Tribune (Jefferson City, Missouri)

Evening Times (Trenton, New Jersey)

New Mexican (Sante Fe, New Mexico)

Times Union (Albany, New York)

Bismark Tribune (Bismark, North Dakota)

Columbus Evening Dispatch (Columbus, Ohio)

Daily Oklahoman (Oklahoma City, Oklahoma)

Oregon Statesman (Salem, Oregon)

Evening News (Harrisburg, Pennsylvania)

Providence Bulletin (Providence, Rhode Island)

Nashville Tennessean (Nashville, Tennessee)

Richmond Times Dispatch (Richmond, Virginia)

Charleston Gazette (Charleston, West Virginia)

Wisconsin State Journal (Madison, Wisconsin)

APPENDIX D

Listing of Magazines
With 1964 Circulation Figures

General Interest Magazines	Circulation*
Life (Weekly)	7,156,487
National Geographic	3,497,354
Readers Digest	14,523,142
Red Book	3,699,457
Saturday Evening Post	6,589,050
Time (domestic and foreign)	3,628,224
Womens General Interest Magazines	
Ladies Home Journal	6,677,673
McCalls	8,220,798

*Based on circulation figures published by N. W. Ayer and Sons Directory of Newspaper and Periodicals, 1964 ed.